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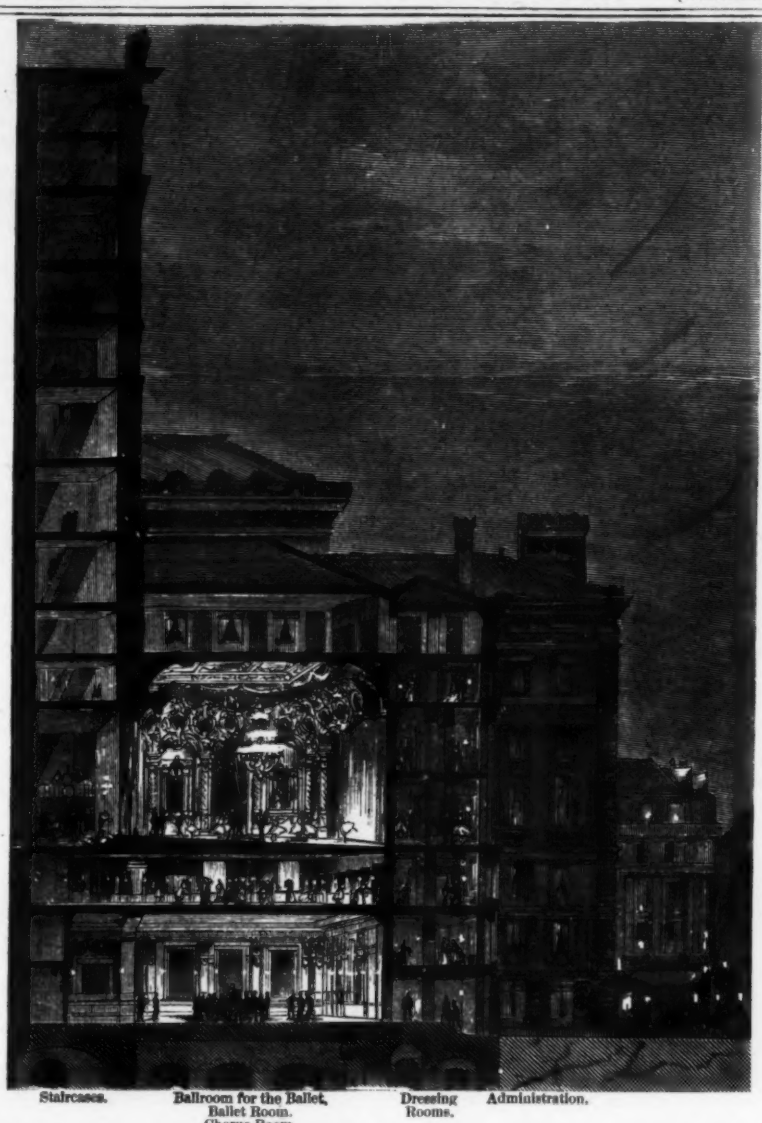
THE PARIS OPERA HOUSE.

THE Grand Opera House at Paris is the most remarkable modern edifice in France. It was created entirely through the genius of one man, the late Charles Garnier, who died August 4 and whose portrait appears in the SCIENTIFIC AMERICAN SUPPLEMENT, September 10, 1898. He was born in 1825 and obtained his architectural training at the Ecole des Beaux-Arts, winning the Prix de Rome in 1848. He entered upon his career in 1861, when he competed for the new Opera House. In 1860 the Minister of the Fine Arts opened a competition for architectural designs for the new lyric theater. This was thirteen years before the old Opera House was burned down and fifteen years before the new one was completed and thrown open to the public. Out of 175 competitors, five were selected to enter upon the second and definitive competition. In the latter competition Garnier won, and the young architect who was almost unheard of at the time was given the most important architectural commission which France had bestowed for two hundred years. Some idea of the enormous cost of the Opera House may be gained when it is said that over 675,295 working days were furnished by masons, bricklayers, carpenters, etc., and the total cost of the building, from first to last, was over $7,000,000.

The Opera House stands at the choicest spot in Paris, being bounded on the north by the Boulevard Haussmann and on the south by the Place de l'Opera, which is formed by the sudden widening of the Boulevard des Capucines. It is bounded by four streets named after composers and librettists, Auber, Scribe, Gluck, and Halévy. It covers more ground than any theater in the world, nearly three acres being taken up by the edifice and its dependencies. It should be remembered that the Opera House really bears the title "Académie Nationale de Musique," so that it is more than a large lyrical theater. Its seating capacity is 2,156 persons, being less than the number accommodated by the Opera Houses at Genoa, Vienna, Munich, St. Petersburg, Naples, and the Metropolitan Opera House in New York city, and the auditorium itself occupies an extremely small proportion of the building; but it should be remembered that in Europe, the government and subsidized theaters and opera houses are not looked on from a box office basis, but are built with a view to architectural effect and for display.

When Garnier received his commission he made a flying visit to foreign theaters before he made definite plans, and in less than nine months after the announcement of the competition the foundation work was begun. It was necessary to make excavations to a depth of about seventy feet, and in the course of the work springs were tapped that seemed to be inexhaustible. A great bed of cement was laid under the water and it was not until the close of 1862 that the masonry could be commenced. Garnier had a temporary house and offices fitted up on the site, and there he lived until the work was well advanced. Under his constant supervision the construction was rapidly carried on, and after seven years, the building was ready for roofing. The Franco-Prussian war, of course, necessitated the suspension of building operations, but it was used as a military storehouse, hospital, barracks, observatory, prison, etc. It escaped by a marvel, and when peace was restored, Garnier persuaded the government to resume the work, and in January, 1875, it was inaugurated in the presence of Marshal McMahon, the President of the Republic. A number of foreign notables were also present, including Queen Isabella of Spain and the young Spanish King, as well as the Lord Mayor of London and his suite.

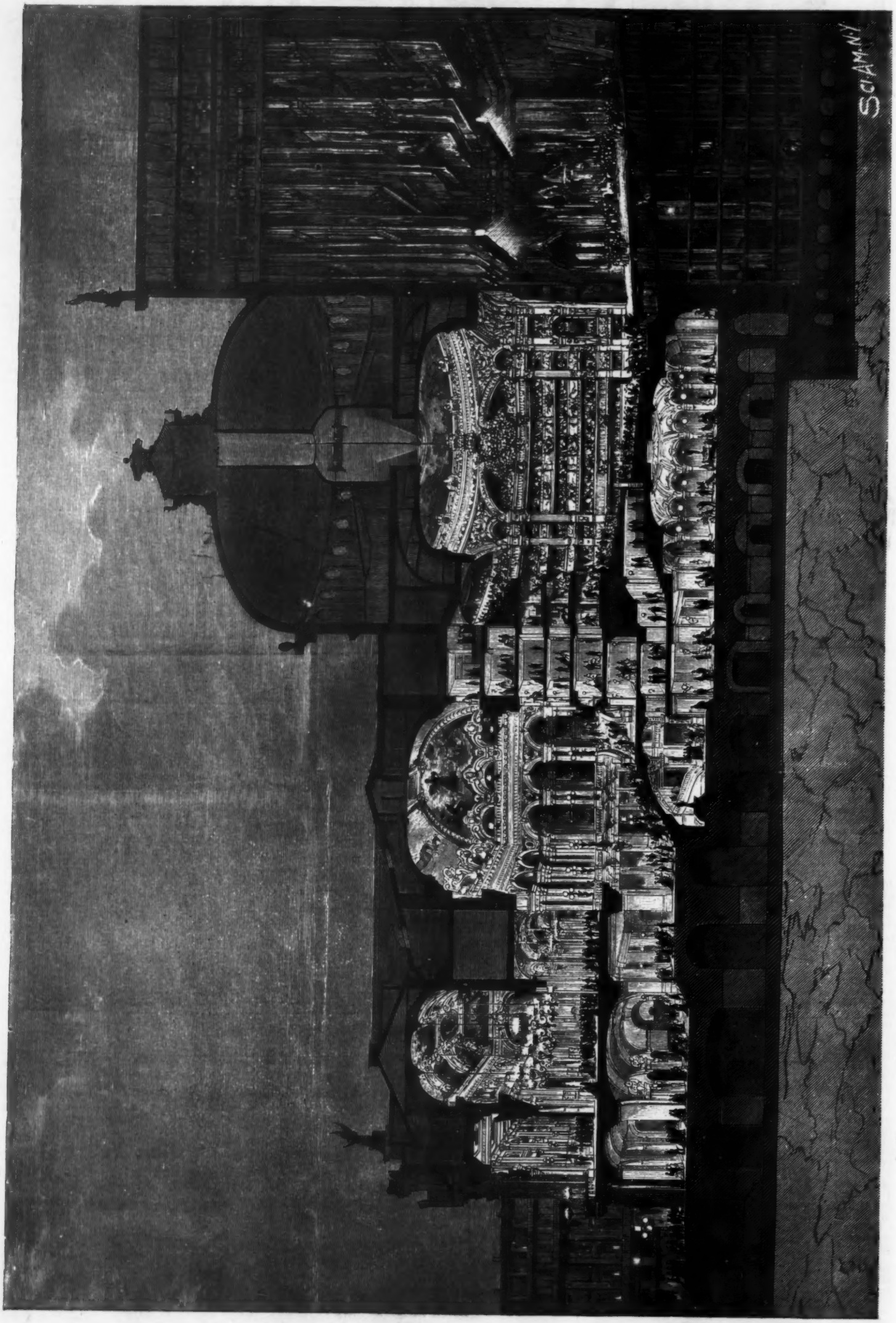


Staircases. Ballroom for the Ballet, Ballet Room. Chorus Room. Dressing Rooms. Administration.

LONGITUDINAL SECTION OF THE REAR END OF THE GRAND OPERA HOUSE, PARIS.

Our engravings show the exterior of the building, the grand staircase, and sections through the building, showing the location of the various apartments. The façade, which is approached by a number of steps, consists of three stories. On the ground floor is the portico, with its seven arches, of which the two outer ones form the principal entrances. Flanking each of these are two large groups of statuary, and the piers between the arches are also embellished with statues and above them are medallions of composers. Above the portico is a loggia with a marble parapet. The cornice and attic are supported by a series of Corinthian columns in pairs. These columns are monoliths, thirty-three feet in height. There are fourteen smaller columns of red marble with gilded bronze capitals which form a kind of frame to the windows. In niches above the windows are medallions, and busts of celebrated composers, such as Mozart, Beethoven, Spontini, Auber, etc. Above the loggia the façade terminates in an arch richly embellished in mosaics and gilded masks and gilded groups by Gumery, one on each side, representing "Music" and "Poetry," and attended by the muses and goddess of Victory. In the center rises a low dome which is not very prominent when the building is viewed near by. The stage section is naturally raised to a great height in order to work the drop scenes, and this feature of the theater or opera house, which is apt to be unsightly, was cleverly concealed by Garnier by means of a huge triangular pediment above the stage, crowned with an "Apollo" with a golden lyre in the middle by Millet, and flanked with two Pegasi by Lequesne. There is a pavilion in the center of each of the lateral façades which are crowned by smaller domes. They give access to carriages. The main façade is admirable from an architectural point of view, but the attic above the loggia is too heavy and dwarfs the fine loggia below. Garnier lightened the attic as far as possible by means of statuary and paneling, but as the building has aged the distinctions which he made so cleverly have been obliterated so that the attic appears to crush the loggia and the arcade below. The entire

THE GRAND OPERA HOUSE, PARIS—FAÇADE TOWARD THE AVENUE DE L'OPERA.


Loggia, Vestibule.
Foyer, Vestibule.
Avant-foyer.
Grand staircase.
Passageways.
Proscenium.
Theater proper.
Pits.

façade is covered with carved detail which is usually in most excellent taste.

The general arrangement of the interior will be seen by the admirable sections which we present. We are indebted for them to La Ilustración Española y Americana. In passing through the gilded gates, we first enter the vestibule, which is adorned with statues, containing the ticket offices, and then pass through two other apartments until the grand staircase is reached. Undoubtedly the staircase is the finest in the world. As far as the first landing, where the entrance to the amphitheater and orchestra is situated, the staircase is single, being about thirty-two feet in width. From this point it divides into two flights of steps which go up in opposite directions. The steps are white marble, the balustrades of "Rosso antico," and the hand rail is made of Algerian onyx. Each landing of the staircases is provided with a balcony, from which the visitor may conveniently survey the interesting scene presented by the richly dressed throng. Thirty colored marble columns separate these balconies; they are grouped in pairs, and rise to the height of three floors. The ceiling is decorated with mural paintings. Passing up the grand staircase, and turning toward the front of the building, we come to the grand foyer, or crush room, which is the most striking feature of the Opera House. It extends throughout the whole width of the building and is entered by the "avant-foyer," the vaulting of which is adorned with mosaics. The foyer is 177 feet long, 42 feet wide, and 59 feet high, and is lighted by ten gilded clusters and several large candelabra. Along the walls are two columns bearing statues emblematic of the

GRAND STAIRCASE OF THE OPERA HOUSE, PARIS.

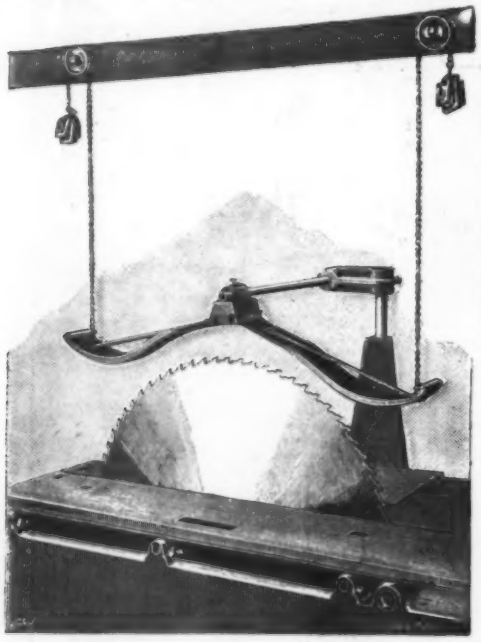
qualities required by artists. Gilding is profusely used in this hall, and a large mirror 23 feet in height is skillfully placed so as to prolong the length of the hall. The ceiling is embellished by mural paintings by Paul Baudry, which are among the best productions of modern French art. The cycle of the paintings is enormous. At each end of the foyer is an octagonal salon embellished with ceiling paintings. A charming street scene of the Place de l'Opera is obtained from the loggia. The "Salle," or theater itself, is reached by the passageways from the staircases. It is fitted up in the most elaborate style, and is richly decorated. There are four tiers of boxes divided into bays by huge columns. The gallery forms a fifth story. The huge chandelier in the center serves to light the vast auditorium. The ceiling paintings are by Lenepveu; they are executed on concave plates of copper. It will be noticed that the roof of the theater is no higher than the roof of the foyer or the great hall, but in order to make the external treatment of the building significant of its use, Garnier built a large false shell, which is placed there purely for the decorative purpose to which we have referred.

The stage is 196 feet in height, 178 feet in width, and 74 feet in depth. As in all theatrical stages, the floor rises slightly. The cellar and the flies do not differ greatly from those in ordinary theaters, with the exception that the machinery used is far behind the age, and does not compare in any way with such modern theaters as the Opera House in Vienna, where a great deal of the work is done by machinery. Our front page section is intended to join on to the end of the full-page section. This shows the Foyer de la Danse, or ballroom, the end of which is formed by a mirror 23 feet in width and 33 feet in height. The walls of this salon are decorated with four large paintings by Boulanger. Around the room, next to the frieze, are twenty medallion portraits of celebrated opera dancers. In addition to the rooms noted, there are various rooms for the training of choruses, dressing rooms, libraries, administration rooms, etc. The Grand Masked Ball is given annually at the Opera House. For our engraving of the grand staircase of the new Opera House at Paris we are indebted to The American Architect and Building News. It is reprinted from the SCIENTIFIC AMERICAN SUPPLEMENT, No. 94.

A NEW RACK SAW GUARD.

THE devices adopted in different manufactories for the protection of workmen against accidents have from time to time been brought by the Home Office inspectors into prominence for the public benefit, and one of the latest of these is the rack saw guard made by Messrs. J. & F. Howard, of Bedford.

The accidents with rack saws working rough timber, unlike accidents with ordinary saw benches, are chiefly due to workmen stumbling or slipping while moving the logs, and a fall on to the saw teeth leads to fearful consequences. The Howard rack saw guard was designed to prevent accidents of this kind, and as the guard is self-sustaining and is adjustable by a touch of the hand, while at the same time it presents no obstacle to the action of the sawyer, it will doubtless be welcomed by workmen. A standard secured at the side of the bed carries an arm adjustable vertically to suit saws of different diameters. On the extremity of the arm a socket is fixed, to which a pair of dished steel wings are independently pivoted, and these wings are supported by counterweights on chains passed over pulleys fixed to a beam overhead.



A NEW RACK SAW GUARD.

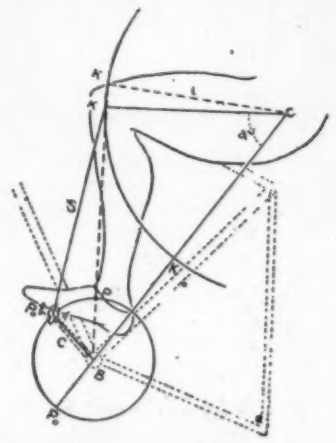
The action of these wings is so apparent in the engraving, and the construction is so simple, that no further explanation is necessary.—The Engineer.

At the congress of the German League of Clockmakers, which lately held its annual sessions in Berlin, Prof. Reuleaux asked them why they did not erect a memorial to the man to whom the trade and the public owed so great a debt. He referred to Peter Henlein, the Nuremberg locksmith, as the inventor of pocket watches. The suggestion fell on good ground. It was at once adopted by the congress, and it has been as quickly welcomed by the municipal fathers of Nuremberg. A "Henlein-Denkmal" is to be set up in the city of Albrecht Dürer, Peter's contemporary. Henlein is said to have made his first pocket watch, the so-called "Nuremberg egg," in the year 1510. He died in 1542.—Westminster Gazette.

DETERMINING LENGTHS OF CRANK.

IT is not new, the declaration that different people view the same subject or object in differing fashion. It is in this differing that the truth is most often discovered. The cut herewith, in connection with a recent article in the English Cyclist by G. T. McCaw, B.E., declares that there is one point in the battle of crank lengths to which too little attention has been paid; that is, the proportion between length of crank and length of rider. The height is a very rough guide; the length of the leg is better, but the proper standards of comparison are the "thigh" and "shank" (to use the Saxon).

The relations between the lengths of thigh, shank,



crank, and the maximum angle of deflection of the leg are easily obtained. Consulting figure, O is the center of oscillation of the leg, i. e., the hip joint, K the knee joint, P the pedal, B the bottom bracket; $OK = t$, the thigh; $KP = S$, the shank; $OPo = l$, the length of leg; $l = S + t$. Now since K moves on the circumference of a circle round O, and P round B, it is easily shown that the maximum angle $BOK = a$ is given by the formula:

$$(\sin \tfrac{1}{2} a)^2 = \frac{S \times C}{t \times (t + S - C)}$$

From this we learn that (1) the angle of deflection increases as the length of shank increases; (2) the angle increases as the length of crank increases; (3) the angle increases as the length of thigh diminishes.

Now, suppose we learn from experience or otherwise the greatest deflection of leg which gives the maximum efficiency under the actual conditions, then we can substitute this value of the angle in the expression on the left side of the above equation, which then becomes:

$$k = \frac{S \times C}{t(t + S - C)}$$

where k is constant for all riders.

From this we deduce:

$$C = \frac{k\,t\,(t + S)}{S + k\,t}$$

$$\text{or } C = \frac{k\,t\,l}{S + k\,t}$$

Three assumptions have been made in the above: (1) That the hip joint remains fixed; (2) that there is no ankle action; (3) that in one position of the pedal the leg is fully stretched. The errors due to these assumptions will not, however, materially affect the result.

The above formula gives the length of crank suitable for a person of shank length, S, and leg length, l.

Now, suppose it has been found that the maximum value of the angle between the thigh and the line joining the hip joint with the bottom bracket (i. e., the angle of deflection, a) is 60°, then the constant, k, is a quarter, and the following table gives the crank lengths for a few lengths of leg and shank:

S—length of shank.	t—length of thigh.	l—length of leg.	C—corresponding crank length.
23 inch.	21 inch.	44 inch.	8·17 inch.
22 "	20 "	42 "	7·77 "
19⅛ "	18 "	37⅛ "	7·00 "
17½ "	16 "	33½ "	6·23 "
15 "	14 "	29 "	5·49 "

It will be understood that the above investigation only deals with one side of the question. It remains to be discussed whether the gear should be fixed proportions of the crank length, say ten or eleven times for strong riders and eight to nine times for weak riders.

The more the foregoing figures, drawings, and table are studied, the plainer will the facts given by Mr. McCaw be proved.—The Wheel.

NEW ROTARY STEAM MOTOR.

THE use of rotary motors, despite their numerous advantages, has not become widespread, for many reasons that it would be useless to detail here, since they are now well known. It is nevertheless true that for certain applications (pleasure navigation and steam automobiles, for example) the simplicity of the rotary motor, the ease with which it is run, started, stopped, and reversed, constitute valuable qualities, the importance of which is beginning to be appreciated.

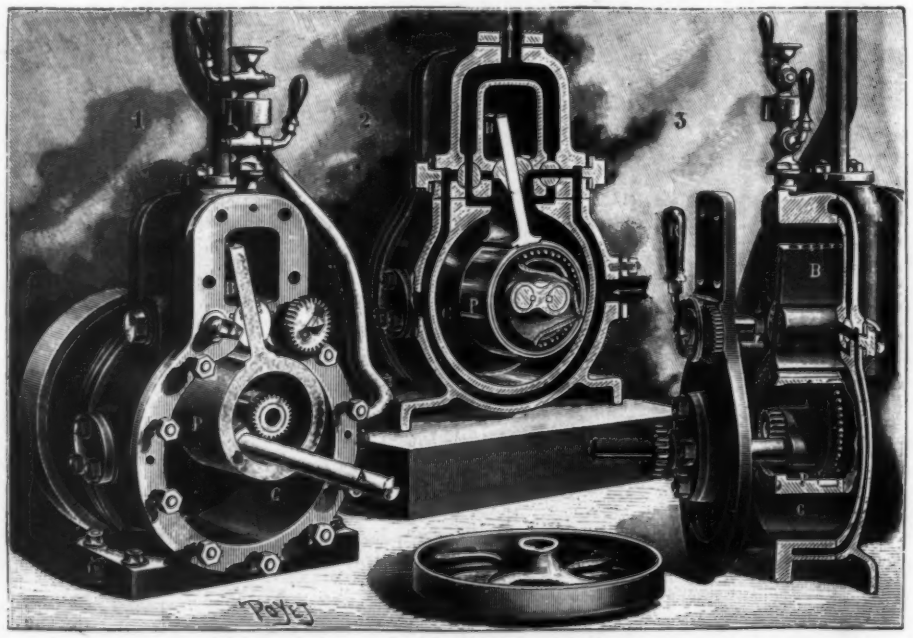
The apparatus to which we are about to call the attention of our readers is known to the industrial world by the name of the πR^2 or $2 \pi R$ motor, an unfortunate intrusion into mechanical terminology of a pun based upon the names of the inventors—Pierre Arbel and Pierre Tihon.

The motor consists of a cylinder, C, surmounted by a chest containing the distributing parts, and of two heads that close the cylinder and are traversed by the driving shaft. In the interior moves the piston ring seen at P, and which transmits the rotary motion to the shaft, A.

In the interior of the cylinder, and keyed eccentrically upon the driving shaft, are two symmetrical cams, united in the center by a rod with a nut permitting of regulating their distance apart at will. The joint between these two cams is therefore situated in the axis of the motor and constitutes a more or less open channel in which is placed a series of tempered balls. The whole is placed in a piston ring, P, that carries the distributing partition, which is of the same depth as the cylinder.

In the interior of this piston ring is screwed a tempered steel ring upon which the balls roll. These latter thus serve as a transmitting intermedium between the piston ring which receives the thrust of the steam and the cam that transmits the pressure to the driving shaft through a rotary motion.

The piston ring, in moving around the driving shaft, keeps one of its generatrices constantly in contact with the internal surface of the cylinder. In its longitudinal direction it carries a steel partition, which serves for the distribution of the steam, and which, like the piston ring, bears through its two faces against the cylinder heads.



A NEW ROTARY STEAM MOTOR.

1. Internal view. 2. Transverse view. 3. Side view.

The height of the partition is such that it remains always connected by its upper extremity with a special joint arranged in the chest, and which guides it in its motions.

The joint is formed of the two symmetrical parts of a bronze cylinder from which has been removed, in longitudinal section, a thickness corresponding to that of the partition. The two remaining segments are provided with two channels for the entrance of the steam. This joint moves by slight friction in a recess formed in the chest and serves as a distributer by opening and closing the entrance of the steam to the

piston ring, according to the position that the latter occupies in the cylinder.

Two cocks placed upon each side of the joint serve, according to the direction of running, to establish either the admission or escapement.

The simultaneous opening of one of these cocks and closing of the other is effected through a single handle, *R*, which controls a toothed wheel that gears with the two cocks.

The reversal of running is therefore effected through the maneuver alone of this handle. The result is that the motor has no dead center, since there is always a direction of rotation in which the piston ring is found in a running position.

The steam, entering through the double jacket of the cylinder, passes through one of the two cocks, according to the direction of running adopted, and enters the cylinder, wherein it thrusts the piston ring.

After the piston ring has made a half revolution, that is to say, after it has reached the lowest part of its travel, the partition, *B*, being vertical, the admission is closed by the oscillatory motion of the joint, which turns off the admission cock.

THE SPENCER AUTOMATIC SCREW MACHINE.

WE illustrate the Spencer automatic double turret screw machine, which is designed for making all kinds of screws and studs, and also for cross-drilling pins and other parts for cycle and electric work. Fig. 1 is a general perspective view taken from a photograph. Fig. 2 is a perspective view of the turret heads, also taken from a photograph. It should be explained that the outline drawings and the perspective views do not represent exactly the same machine, but the two are alike in general principle. Other figures show the details of construction. The machine is of American design, Messrs. Burton, Griffith & Company, of 158 Queen Victoria Street, being the agents for the sale of it in this country. The chief features in the design are a primary and a secondary spindle, working in combination with two turrets which revolve in vertical planes, and are driven by one shaft through the medium of a chain and sprocket wheel as shown. The primary spindle carries the revolving rod from which the part is to be formed, and which is operated upon automatic means. Mr. Spencer, in designing this machine, set himself the task of solving this problem and has succeeded in a most ingenious manner.

The main spindle carries the three pulleys marked. The center one of these pulleys is fastened to the main spindle, while the outer ones are loose, reversal of motion being obtained by an open and a crossed belt respectively. There is an automatic belt shifter by which reversal of motion is obtained by means of a lever which is actuated by cams which are operated through the medium of the camshaft, which is placed beneath the bed of the machine, and to which is attached the worm wheel gearing into a worm pinion. The large worm wheel at the right is the driving pulley for this gear, and drives the cam at the required speed. At the two opposite ends of the cam shaft are the drums, and on the periphery of these are fixed the cams which give the required motions to the various parts of the mechanism. The wire or rod is held, while the cutting operations are performed, by a chuck. This chuck is actuated in a manner which will be familiar to many of our readers. There are two tubes within the hollow spindle. The conical collar, which slides upon

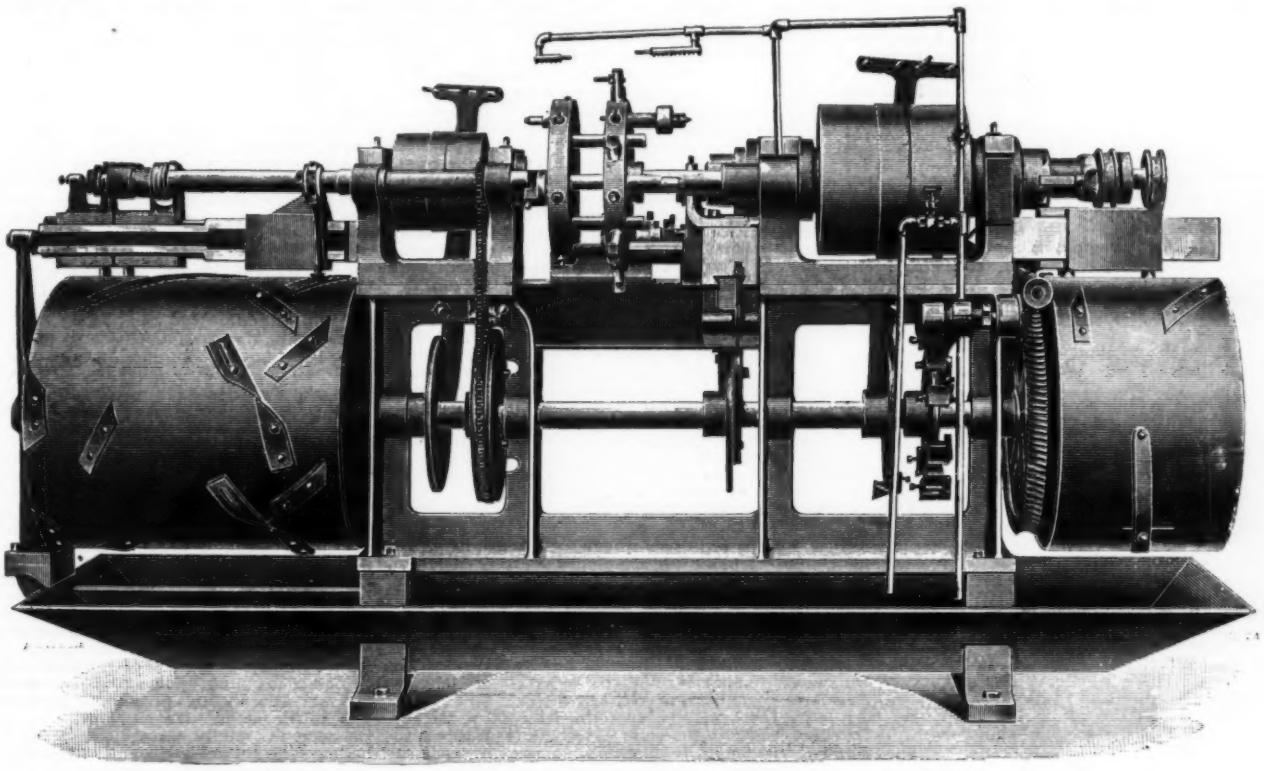


FIG. 1.

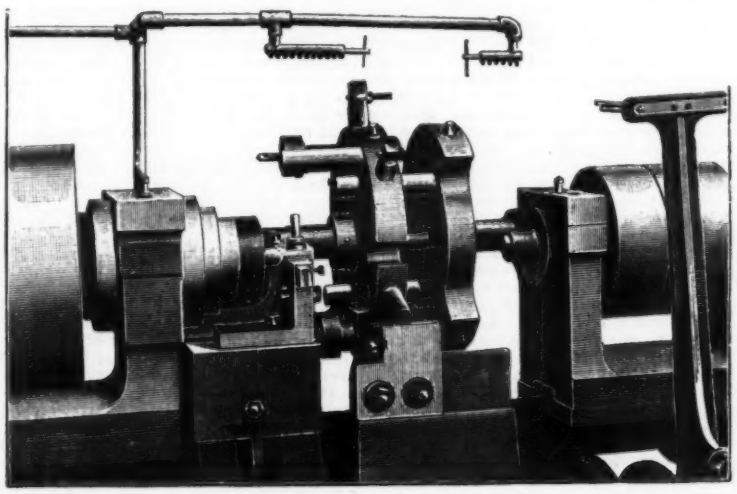


FIG. 2.

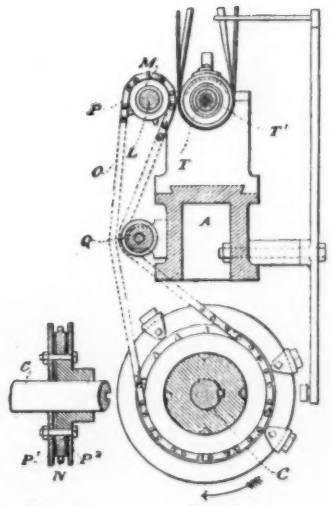


FIG. 4. FIG. 3.

THE SPENCER AUTOMATIC SCREW MACHINE.

The steam admitted then expands and continues to cause the piston ring to ascend.

After the partition has resumed its vertical position, that is to say, after the piston ring has reached the highest point of its travel, there is an immediate communication between the entire interior of the cylinder and the escapement through the second cock Immediately afterward, the joint opens the first cock again, and there is a new admission of steam, with a reproduction of the cycle that we have just described.

The lubricating is done through a single lubricator, which oils all the parts. A very original arrangement assures perfect tightness. Upon the entire surface of the lateral faces of the piston ring and of the partition there is formed a series of recesses into which is compressed a packing of cork that comes flush with the surface of the metal. Under the influence of the humidity of the steam, the cork swells and presses against the faces of the cylinder so as to form a perfect joint with very slight friction.

A motor weighing 310 pounds, inclusive of the flywheel, produces 6 H. P. with steam at a pressure of 140 pounds to the square inch.

For the above particulars and the illustrations we are indebted to La Nature.

by tools carried in the forward turret. The second spindle takes the part after it has been detached from the rod, and which is worked upon by the tools carried in the other turret. Such being the main points of the machine, we will proceed to describe the method of working in detail by means of our illustrations.

At the time we saw this machine at work it was employed in forming head clip pins for bicycles. The part is a simple thing in itself, but would require several operations if formed in the usual way by means of ordinary lathes and screw machines. The machine under consideration is essentially a labor-saving tool, and turns out the work in a remarkable manner both in regard to rapidity and accuracy; the latter feature being, of course, a cardinal virtue in regard to work where different parts of a complex finished article, such as a bicycle, are required to be put together without hand fitting. Hollow spindle machines with a chuck and wire feed, by means of which a continuous rod or wire is formed into separate parts by means of turning tools or screwing dies, are not uncommon, as our readers are aware. When an article with two forward ends has to be produced, or when the familiar problem of cutting a slot in a screw is met with, difficulty has been experienced in carrying the work to an end by

the main spindle, acts upon the bent levers, and in this way end motion is given to tube, which in turn clamps the jaws of the chuck on the rod or wire. The sliding collar receives its motion from cams on the drum at the right, while other cams on this drum give motion to the feed tube through the collar. In this way the jaws of the chuck are opened and closed at the required time, as the article being made has to be held to be operated upon or released, and a further length of wire or rod fed up. As stated, the arrangement is tolerably well known, and does not need detailed description. The turrets, as stated, revolve in vertical planes, instead of horizontally, as is usually the case. For this reason the name given to them is inappropriate, and they had better been called tool plates. The left hand turret is mounted on the shaft, while the second turret is firmly attached to the tube which surrounds the shaft. The shaft can be moved endwise within the tube, being actuated by suitably placed cams on the large drum. To effect this a grooved collar is attached to the end of the shaft, and this is moved longitudinally by means of the slide box, which has attached to it a hanging stud to be acted upon by one of the cams on the drum. In this way end motion is given to the shaft, and the tools on the turret are thus brought up to the

work as required. Studs are permanently attached to the secondary turret and pass through holes in the other turret, as also shown in the perspective view, Fig. 2. These studs cause the two turrets to be rotated together, although the turret can be moved longitudinally, together with its shaft, in the manner already described, independently of the secondary turret. Upon the primary turret projecting stops are placed, and these come in contact in revolving with the arrester, which is attached to the lathe bed, the two being held in contact for the desired time by a rotating device to be presently described. When the turret receives endwise movement, and the stop is in contact with the arrester, the former is drawn along the top edge of the latter, the rotary movement of the turret is thus destroyed, and the cutting tool is held in place time enough to perform the required operation. At a given time the stop passes off the end of the arrester, and the turret revolves until another stop is brought into place, whereupon the revolution of the turret is again checked, while another tool does its work. As the stops are more distant from the shaft than the cutting tools, there is little risk of vibration, the arrester forming a rigid support, while the rotating device continuously presses the stop into contact with the arrester.

For rotating the turret a sprocket wheel is placed on the cam shaft, and is geared by means of a chain to a corresponding sprocket wheel above the bed and surrounding the sleeve and shaft on which the turrets are mounted. In order to keep the chain clear of the bed, a guide wheel is provided, as shown in Fig. 3. The sprocket wheel on the cam shaft is between two flanges, P^1 and P^2. The latter has a hub fastened to the cam shaft, while the flange, P^2, is in the form of a disk that can be set up by bolts so as to apply friction to the sprocket wheel; washers of leather being used for the purpose. This detail is shown in Fig. 4. The two flanges will continue to rotate although the sprocket wheel may be stationary, as it will be so long as the stop before mentioned is in contact with the arrester. The direction of rotation is in the direction that tends to keep the stop firmly against the arrester, as before explained, while the turret will be turned by the friction washers between the flanges and the sprocket wheel as soon as the stop passes beyond the arrester. By means of this slip friction arrangement, the tools are successively brought up to the work as required. Any convenient number of cutting tools may be used.

From what has been said so far, it will be gathered that parts to be produced are shaped from the continuous rod or wire which is fed up through the main spindle of the machine. The rod projects beyond the end of the clamping tube and chuck head the necessary distance for the article to be made. The tools on the turret head are brought into play in the way described.

We now pass to the further operations which are a special feature of this machine. Supposing, for instance, a screw thread has to be formed upon the article. The turret head comes round so that the opening is in line with the main spindle. The secondary spindle is projected so as to pass into or through the turret head, more or less, and grasp the article that has been partially made before the latter has been separated from the rod. This secondary spindle is supported in bearings and is driven by three pulleys. The central pulley has a key engaging in a longitudinal groove in the spindle, so that the endwise movement can be given to the spindle as it rotates. There are crossed and open belts to give reverse motion in the usual way, or the spindle can be kept at rest by the belts being kept on the loose pulleys. There is a friction pad carried on a spring arm which will prevent the spindle from being caused to rotate accidentally. The belts are shifted by a wheel on the cam shaft through the medium of shifting inclines.

At the inner end of the secondary spindle is an automatic chuck, worked by a rod inside the spindle, there being a sliding collar acting upon bent levers for the purpose, the motion being obtained from a cam on the cam drum. The slide box is guided by a slide which projects from the frame of the machine, and upon the same slide is a slide box which has a stud engaging with cams upon the drum, and on the slide box there is a stud which engages in the collar which is placed on the back end of the secondary spindle. This latter mechanism gives endwise movement to the spindle. It will be noticed that the slide boxes move together, so that the article is held by the closed chuck when the secondary spindle is being drawn back, but when the tooling operations are performed, the chuck will be opened by the slide box by means of a pointed cam, and the part will be thrown out by the spring inclosed in the chuck. The secondary spindle receives an end movement when the opening in the turret head is in line with the spindle. The chuck on the secondary spindle then grasps the article by the means described and draws it back through the opening, and the article can be further machined as may be desired on its freshly exposed end.

It will be readily understood that the arrangement of cams in both cam drums must be set out with great nicety, and with so ingenious and complex a machine, where motions are so interdependent, the best workmanship only is admissible. There are three chief advantages claimed, and justly claimed, for this machine—namely, accuracy, range, and speed. The first is assured by the method of holding the turrets rigidly to the hardened steel rest during the time the tools are in operation, as described. Range of work is due to the introduction of the secondary spindle and rear turret, while speed of work follows from positive movements, as well as from the holding of the turrets by the stops.—Engineering.

THE DETERMINATION OF SEX.

THIS year we have witnessed the reappearance of a question that is as old as the world, and one in which the public has always been interested. We refer to the question of the procreation of the sexes, or, more exactly, of the determination of sexuality.

Is the egg, from the moment of its formation, predestined to give a male or a female being, or is it, on the contrary, asexual and capable of taking one sex or the other under the influence of circumstances or under the action of external factors? Hippocrates believed (and the belief has remained popular up to a certain point) that germs exist for each sex and that they are differently localized. This old hypothesis has just been taken up with a slight modification by Seligson, who thinks that the young will be male or female according as the egg is derived from one ovary or the other. In support of this theory, he produces some statistics and a series of experiments. The former consists of a table of clinical observations bearing upon tubal placentations, while the experimentation consists in a unilateral ovariotomy of the rabbit. But Seligson's statistics are invalidated by other and more recent ones given by Gessner, who, in addition, establishes the fact that all such statistics are faulty. A right tubal placentation may come from the left ovary, and inversely, as shown by the position of the corpus luteum. As for Seligson's experimental arguments, we do not know that they have been directly contradicted, but we shall see in what follows that every fact presumes their inaccuracy.

In many cases it has been possible to demonstrate that the egg gives males or females according to circumstances which, being perfectly known, may be brought about. Last year M. de Kerhervé, while studying a colony of Daphnia psittacea (a small crustacean very common in brooks and ponds) observed that these animals when abundantly fed were all females, which reproduced their kind without fecundation—by parthenogenesis; but that when the alimentary ration was diminished the eggs gave females and males, with a frequent predominance of the latter. Sometimes, even, males exclusively appeared. The same phenomenon supervenes normally when the heat of summer dries up the ponds and when the cold of winter comes on, and, in a word, whenever the conditions become bad and the species is threatened. A similar fact has been pointed out by the same observer with regard to other crustacea, such as the Branchipus. It was ascertained a long time ago with regard to the plant lice and a number of the hymenoptera and lepidoptera. Born in 1880 and Yung in 1882 operated upon the tadpoles of batrachians, and supernutrition gave them from 78 to 95 per cent. of females, while in nature the normal proportion is but from 54 to 61 per cent. In 1891 Maupas resumed these experiments with an infallible method, and, in a colony of rotifers—the Hydatinas—obtained males or females at will by lowering or raising the temperature.

In the vegetable kingdom we have the same law. Hoffmann has shown that in dioecious plants the same seeds give a majority of male plants or a majority of female ones, according to the fertility of the soil. Hemp, however, seemed to escape this law with such constancy that Hoffmann was led to infer asexual predestination of its seeds. Now, this year Molliard, upon sowing some hemp seed, taken at hazard, in proper soil, obtained plants that were exclusively female or had female tendencies; and the alleged exception enters purely and simply into the law. From all this it may be concluded that the egg, that the embryo, even at its beginning, is, as a general thing, indifferent from a sexual standpoint, and that external factors then determine the evolution of the being. Proper conditions of food and temperature in most cases produce females. This law may not be general. In the egg, especially if it is large, there may be enough elements of vigor or feebleness to cause the embryo to be irrevocably sexualized at the instant it engages in a struggle with the external medium. In particular, if it is a question of a viviparous being, the problem becomes singularly complex. Giron de Buzareingues, as long ago as 1826, showed that if we pair young, vigorous, and well fed ewes with old and sickly rams, we shall generally obtain female lambs, and that conversely we shall in most cases get male ones. From this he deduced the conclusion that the more vigorous parent produced offspring of its own sex. In reality, the influence of the mother appears to us to-day to be predominant. She gives the lamb such or such a sex according to the kind of food she furnishes. Dr. Schenck, a physician of Vienna, has recently come forward and asserted that he is able to produce the birth of a boy or girl at will, according to the regimen that he prescribes to the mother. A priori, this is not in contradiction with what we have just said, although doubt will be permissible until we have more information. The food of the mother is reflected upon the embryo in a very indirect manner. Hundreds of circumstances may intervene to prevent the embryo from being well nourished, despite the perfect alimentation of the mother. Such or such a position of the young one may constitute for it one of those untoward circumstances that tend to assure it the male sex; and that is so true that twins are often of different sexes.—Revue Rousse.

PSYCHOLOGICAL CAUSE OF LAUGHTER.*

AT the beginning of our inquiry we meet the common opinion that the feeling of laughter is caused by joy. This has the merit of simplicity; but joy does not always make us laugh, for there are serious joys; and we frequently laugh without being joyful, and even sometimes at things that are sad. Another opinion, to which Darwin inclines, is that laughter is provoked by what is queer, unusual, by what disagrees with or is contrary to our mental habits, or interrupts the familiar course. The queer, the old-fashioned, the provincial, partake, we admit, of the ludicrous. Caricatures amuse because of their exaggerations of proportions in contradiction to all natural laws. We recognize that there is something queer in everything that excites laughter, and that no word, act, situation, or attitude can be really laughable without having something strange about it. Yet the queer does not always make us laugh. There are things contrary to the normal order that have nothing ludicrous about them; and if the view were true that queerness is the laughable element, those things which are strangest and most unusual should be the very ones most certain by their very nature to excite laughter. But we do not laugh at the dancing horses, the jumping pigs, the musicians playing on bottles, of the circus, all of which are most contradictory of what we are accustomed to. If we laugh at the circus, it is at the accessory jokes and incidents in the detail. A conjuror's tricks, seemingly contradictory as they are of all our experiences and notions, do not make us laugh. We laugh at his jokes and his funny ways of proceeding, but wonder at the tricks.

In a theory proposed by M. Penjou, in the Revue Philosophique, laughter is excited by whatever appears as free and exempt from law, and as produced by a playful activity or the capricious manifestation of an unrestrained will, as in jokes, plays on words, equivocations, a schoolboy's pranks, deformities, or freaks of nature. "The same cause of laughter," he says, "will be found in all the cases I can cite. They always involve, under a thousand shadings, the sudden manifestation of a freedom that destroys our prepossessions, but without harm to us or real injury to others. However we may regard it, it is always this abrupt, spontaneous outburst, with the entire absence of ostensible cause, that makes us laugh. . . . Spontaneity or liberty makes us laugh, and is, in fact, the essence of the amusing and the ludicrous in all their forms; and laughter is simply the expression of a liberty we feel, or of our own sympathy with the real or fancied manifestation of another's liberty, and is the natural echo in us of liberty." This hypothesis, with a few minor variations, is simply the theory of the odd. We are ready to acknowledge that there is considerable truth in this view. Liberties are taken with words in a pun and with æsthetics in a grimace. Such freedoms are, however, often exhibited to us without our feeling any inclination to laugh. For an extravagance or a caprice some trait which has not yet been determined must be present.

Another considerable prevalent theory supposes the abrupt perception of a contrast between the attempt and the outcome, the appearance and the reality, the mask and the face, the tone and the words, the form and the substance, that provokes laughter. "Laughing," says Hegel in his Æsthetics, "is a sign that we are wise enough to comprehend the contrast and take note of it." According to L. Dumont, it is occasioned by the conflict in our mind of two contradictory thoughts, causing a shock. "The recognition of an object," he says, "at first gives a certain impulse to our understanding and stimulates its activity in a certain direction, when immediately a contradictory impression of another quality of the same object comes in and forces it into a contrary direction." Still the same common theory of contrast, except that with Dumont the contrast rises to a contradiction.

Let us study a few cases: first, of what we find to amuse us in acts, and then in words. We find the application of great effort to move a load that proves to be a trifle, ludicrous; as when a man exerts all his strength to force open a door that yields at a touch, or when the clown on the stage brings all his strength to bear to lift the mock cannon ball which we know is only pasteboard. Our first impression of such actions is that they are strange or absurd. Such Herculean efforts to raise a load we know to be trifling, to overcome a resistance which we know is as nothing, are, on the first impression, incomprehensible. A second impression, however, comes on, which the psychologists seem to have missed, and which may go far to account for the ludicrous aspect of the proceeding. A rapid process of thought within us makes the act which at first seems absurd appear natural from the point of view of the actor. We think that the man supposed the door was solidly fastened, and the clown that he had a real cannon ball to lift. The effort they made was therefore natural; we should have strained ourselves too if we had been in their place, and all for nothing; and we laugh at that. What seemed queer was simply natural, an unusual fact was a habitual one, and what we thought was surprising was after all familiar. We experience a sudden revulsion of feeling, and are amused. So in words and expressions which we regard as witty or funny. They are first presented to us in a sense and with associations which seem queer or remote; then we find that they have also a natural and even simple interpretation. Our natural surprise at the discovery is expressed in laughter.

In the scenes which comedians present upon the stage these double interpretations and instantaneous transitions of feeling are artfully provided for, and the success of the comedy is proportioned to the skill and plausibility with which they are worked up. When the play turns upon complicated situations and the mistakes and blunders of the character, we first perceive the absurdity of the whole as seen from our position; then instantly recognize that with the actors the matter is a serious one, and that what they are doing is correct from their point of view. The point of the joke lies in this double perception. Laughter is favored by various circumstances and conditions—as a good state of physical being, infancy and youth, exultation over success, the buoyancy we feel after having escaped danger, and cheerful moods. Some writers have sought the causes of laughter among these conditions; but we think they are only incidents, and simply help it by promoting freedom and agility of the mind. Children, who have no fixed habits, and are vastly more susceptible to impressions than their elders, perceive the different sides of objects and their contrasts more speedily than they, and are more prone to laughter. Mental dullness, physical trouble, disappointment, mistakes, anxiety, or mental pain are restraints upon laughter, or prevent it. Thus the more a thing appears to us at once unusual on one side and familiar on the other, the greater is the tendency to laughter; and the less pronounced the contrast, the less we are amused at it.

* Camille Mellinand in the Revue des Deux Mondes. Translated for Appleton's Popular Science Monthly, New York. Condensed for Public Opinion.

Returns to the Geological Survey show that the total production of lead in the United States from all sources during the first six months of 1898 was 156,113 net tons, as compared with 289,598 tons during the year 1897 and 264,994 tons in 1896. This includes soft lead, hard lead and the metal obtained by smelting foreign base bullion and ores in bond. During the first half of 1898 there were exported 33,439 tons of lead from foreign base bullion refined in bond and 7,308 short tons of lead from foreign ores smelted in bond. Reports from nearly all the important producers show a decline in stocks from 17,608 tons on January 1 to 16,760 tons on July 1. The estimate of consumption for the first half of 1898 is 118,767 short tons. The figures presented indicated an increased production in this country, balanced fully by a notable growth in the consumption, which is at the rate of 237,000 tons per annum.

ELECTRICAL NOTES.

The Canadian Pacific has now completed its direct copper wire from Montreal to Vancouver, a distance of 2,897 miles.

Electric lighting from the car axle has been adopted on the limited train of the Atchison, Topeka & Santa Fe Railroad, running between Chicago, Ill., and Los Angeles, Cal., a distance of 2,209 miles. The aggregate candle power generated will be about 4,928 candle power, including, besides the regular train lights, lamps in all berths and the locomotive headlight.

One of the lieutenants of the U. S. S. "Texas" has been interviewed with regard to the value of the electrical equipment of the battleships during the blockade of Cuba. He thinks the telephone and searchlight the most valuable parts of the equipment, and adds that the use of the searchlight made it utterly impossible for the Spanish commander to have crept out under the cover of the darkness, as some of his critics say he should have done.

L'Illustration, remarking on the number of telephones in service in the United States, deplores the lack of readiness to employ these instruments in Europe. In Berlin, where there are 30,000 in use, the average number of calls is not more than seven a day—two in the morning and three or four in the afternoon. Among the European countries, Germany and England hold the lead, with 140,000 and 116,000 instruments, respectively. In France there are scarcely more than 35,000; while there are 62,000 in Sweden, 35,000 in Scotland, and 30,000 in Switzerland. There are 700,000 in use in the United States.

The possibilities of electrical combination locks for cash drawers and similar receptacles does not seem to have been realized to its fullest extent, says The American Electrician. It requires but little ingenuity to arrange four or five push buttons in such a way that only one combination will close the circuit of an unlocking magnet, and any other will ring an alarm. The alarm could be placed at any convenient point, and at other points could be placed cutout switches which, when manipulated, would render it impossible even for one who knew the combination to succeed in opening it. The device is easily developed and marketable.

The water taken from the Bruges Canal, at Schoorebrugge, is first filtered in the usual manner through beds of different kinds of sand, and is finally pumped through sterilizers, being there subjected to the influence of an electric current at a pressure of 1,000 volts, says The English Electrical Engineer. It is stated that by this means all traces of microbes are entirely destroyed, and the pure water is distributed to the inhabitants of Blankenberge by means of the system previously in use. About 35,000 cubic feet are treated per day in summer, this value falling to about 10,000 cubic feet per day in winter. The electrical installation has an output of 55 horse power. The system, which was invented by Baron Tyndal, has been established in its present practical form by M. Schneller.

An exceptionally heavy rain recently interfered with the working of the conduit electric road in Washington, D. C. Heretofore it has been reported that the cars were not delayed when the conduits were filled with water, but it appears from press reports that last week the previous good record could not be sustained. The conduits were filled about four o'clock in the afternoon, short-circuiting the conductor bars and resulting in melting the plow of one of the motor cars and also setting fire to some of the woodwork of the car. The damage to the car, however, was insignificant. This occurrence should in nowise reflect on the conduit electric system, but rather on the methods of draining the conduits. It would be only natural for the current to be short-circuited if the conduits were filled with water.

The electric tramways of Switzerland on July 1, 1898, had a total length of 69 miles in actual operation and 64 miles under construction; concessions for 200 miles more had been granted to different companies. Water power is usually available for generating the current. The usual gage is one meter. The overhead system is generally used, with copper wires 6 to 9 millimeters diameter, elevated from 16 to 20 feet above the road surface. In the establishment of new lines alternating currents are generally employed, with a maximum tension of 750 volts, as fixed by law; when continuous currents are used the maximum tension is 1,000 volts. The motor cars weigh from 9,900 to 16,500 pounds and carry from 22 to 45 passengers. Handbrakes, working on 4 or 8 shoes, are usually applied to the wheels. For the tramways of Fribourg and Lausanne, where grades of 9·2 to 11·3 per cent. are met with, the heaviest grades on simple friction railways in Europe, very strong safety brakes are employed, in the form of spurs that may be forced into timbers running parallel to the rails. Speed on the Swiss tramways is fixed by law at a limit of 7·5 miles per hour in cities and towns and 15·5 miles in the open country.

In the London trunk telephone exchange at St. Martin's-le-Grand a large clock, in view of all the operators, is used for timing the messages, says The Western Electrician. It is provided with a large hand, which moves a quarter of a minute at a time, and the operator notes the time of commencement of the conversation as a quarter minute later than the dial reading, so that the public has the advantage of all fractions of a quarter minute. It is said that clocks are used at other places in England for similar service and in most of the Continental exchanges. In the exchange at Berne there is a very primitive but sufficiently accurate timer in use, namely, the sand glass. Two sand glasses are provided for each trunk wire, and are fixed in the corresponding position on the switchboard. The second glass is necessary in case the conversation has not lasted exactly the specified time, in which event the operator need not wait for the sand in the first glass to flow out before giving the trunk line to a new applicant. The London Electrician believes that such a system, with a shutter added to prevent the wrong glass being read, would be as cheap as clocks and more reliable, and quite as useful as any of the more expensive methods.

MISCELLANEOUS NOTES.

According to a report by a United States consul in Germany, coke is much used in stationary steam plants where smoke is an objection. In 1894 about 7,900,000 tons of coke were thus used in Germany—an increase of 11 per cent. upon the previous year's consumption.

"It is very probable that from now on to Christmas the export trade in live cattle and dressed beef will be of such a character as to yield handsome returns to those engaged in the industry," says The National Provisioner. "The British markets are now in good shape, and the result is that exporters are increasing their shipments, although vessel space is not hard to secure. So promising, however, is the outlook that the resumption of sheep shipments is talked about. Among other things which may be noted in relation to the export trade in live cattle is that John Bull's idea as to the character of the cattle he requires is undergoing a change. It has been demonstrated during the past few months that nice, fat, medium-weight cattle sell better and make more money in London and Liverpool than the big, heavy, fancy steers, and the more conservative shippers are now sending forward cattle weighing about 1,200 or 1,300 pounds. They cost less in the West than the heavier cattle and sell better in England."

Although the war with Spain lasted only 114 days, it is estimated that it has cost the government so far $150,000,000, of which $98,000,000 has been actually paid out of the Treasury, says The Wheel. Beginning with March 1, when the first increases in the expenditures in anticipation of war became apparent in the daily expenditures of the Treasury, the actual disbursements on this account have been approximately as follows: March—Army, $600,000; navy, $2,400,000; total, $3,000,000. April—Army, $1,200,000; navy, $9,800,000; total, $11,000,000. May—Army, $12,000,000; navy, $7,000,000; total, $19,000,000. June—Army, $16,500,000; navy, $6,500,000; total, $23,000,000. July—Army, $29,500,000; navy, $5,500,000; total, $35,000,000. To August 13—Army, $5,500,000; navy, $1,500,000; total, $7,000,000. Total charged to War Department, $65,300,000. Total charged to Navy Department, $32,700,000. Grand total, $98,000,000. The appropriations made by Congress on account of the war aggregate about $360,000,000, and cover the time to January 1, 1899.

The loss in the United States navy, in the war with Spain, was only 17 men killed and 67 wounded, and of the latter 54 returned to duty. Surgeon-General W. K. Van Reypen, U.S.N., Chief of the Bureau of Medicine and Surgery, has handed in his official report. He shows that the United States navy, before the war commenced, secured competent surgeons from civil life to meet the possible demand for them on auxiliary vessels, and commissioned 37 as assistant surgeons out of the 2,000 applications received. The Bureau fitted out as a hospital ship the "Solace," a steel vessel of 3,801 tons, a speed of 16 knots, and comfortable accommodations for 200 patients and the medical staff. She was ready to take the wounded at the bombardment of San Juan. The "Solace" made numerous trips to Northern ports and went back loaded with all manner of supplies for the sick. The medical officers of the "Solace" first introduced antiseptic surgery at sea. Throughout the report there is evidence of careful and intelligent preparation for all emergencies by the naval medical staff; and the small percentage of loss of life from wounds and the general good health of the navy is proof of the efficiency with which the medical officers discharged their duties.

The removal from Havana of what are supposed to be the ashes of Christopher Columbus has brought forth the fact that almost as many cities claim the honor of being his birthplace as in the old couplet "claimed the Homer dead, through which the living Homer begged his bread." Historians say that the great navigator was born in a village near Genoa—but there are many villages near Genoa. Among the claimants for the honor of giving to the New World a discoverer are Pradello, Finale, Onegalia, Nervi, Savone, Albissola, Bogliasco, Cogoleto, and a dozen others. It is not generally known, however, that the Corsicans of the little town of Calvi claim precedence over all seekers for this particular fame. They have preserved there a record covering the years from 1435 to 1450 which is said to contain the birth register of Columbus. At this time Corsica was under the administration of the Genoese. Not only have the people of Calvi a Colombo Street, where they point out the ruins of the navigator's birthplace, but they have a tablet which was erected there with great ceremony on May 30, 1886. The inscription reads as follows: "Here was born in 1441 Christoforo Colombo, immortalized by the discovery of the New World, while Calvi was under the domination of the Genoese; died in Valladolid, May 20, 1506."—New York Times.

The very finest of doors are made nowadays of veneer on a body of pine. Even when made of mahogany or some other costly wood, doors have to be veneered. The body of the door is made of a plain, straight-grained mahogany, while the surfaces are veneers of fine wood. In the finest doors the body is made of selected white pine, free from sap and perfectly seasoned, which is cut into narrow strips and then glued together. The outer edges of this door are faced with what is called a veneer, but which is really a strip of the fine wood half an inch or more in thickness. The inner edges of the frame, by the panels, are covered in the same manner with thick strips, in which the ornamental mouldings or carvings are made, and which are grooved to receive the panels. This built-up frame of white pine, with edges of the fine wood, is then veneered with the fine wood. In some lighter doors the panels may be of solid mahogany, but in the finer, larger, and heavier doors the panels also are made of sheets of white pine with a veneering of the fine wood, so that the entire door is veneered. It would be difficult, if not impossible, to procure at any cost mahogany lumber in fine and beautiful woods of sufficient size for the larger doors. The built-up and veneered door of pine wood, however, has every appearance of a solid door, and, made of selected veneers, it may be more beautiful than a solid door would be. It is more serviceable and remains longer perfect. Its cost is about half what a solid door would cost.

SELECTED FORMULÆ.

To Preserve Plant Colors.—To preserve the colors of plants, one must kill the specimen as rapidly as possible, and not have it die slowly between the drying papers. Some plants, like stone crops, orchids, and other succulents, will live for months, and then the leaves and flowers will rot away in dreary blackness at last, besides throwing off their leaves and flowers, giving only a few dry sticks for one's trouble. The best way to effect this desirable taking of life is to dip the specimen for a few seconds in boiling water. After taking from the water, the specimen may be allowed to dry a little before putting it in the press.—Meehan's Monthly.

New Liquid Glue.—The following is the subject of an English patent, and is said to yield a glue liquid at all ordinary temperatures, of great adhesive properties, and which does not mould: Let any desired amount of gelatin or glue swell in cold water until it has taken up the maximum of that substance. Pour off and work out all excessive moisture, then liquefy by the application of heat (in a water bath). To the solution add 10 per cent. of the original weight of the gelatin or glue, of sodium salicylate, and dissolve. A small addition of oil of clove is recommended. This, as we understand the description, constitutes a stock, which is to be diluted for use as desired.—National Druggist.

Preserving Fruits.—A compound for the preservation of fruits, vegetables, etc., in the raw state has the following formula:

Boracic acid	1 part.
Salicylic acid	1 "
Sodium carbonate	1 "
White sugar	16 "
Water	32 "

Mix and dissolve. Of this sirup add 1 part to 6 parts of water to make the preserving liquid. A variation of this, said to be better as a preservative, is as follows:

Salicylic acid	1 part.
Sodium carbonate	1 "
Alum	1 "
Sugar	1 "

Dissolve in 128 parts of water to make a stock solution. Add 1 part of the solution to 8 parts of water to make the preserving liquid.—National Druggist.

Pads for Rubber Stamps.—Dieterich gives the following in his Manual: Boil 35 parts of Japanese (tien-tian) gelatin in 3,000 parts of water until completely dissolved. Strain, while boiling hot, through flannel, add 600 parts glycerine, return to the fire, and evaporate to 1,000 parts. With this liquid as a basis, make the ink of the color desired, using 60 parts of methyl-violet (3 B) for violet, 80 parts eosin (B B N) for red, 80 parts of phenol blue for blue, 50 parts anilin green for green, and 100 parts of nigrosin for black. With this ink saturate the cushion of the pad box and cover with mull. If at any time the surface becomes too dry, moisten with water or glycerine. The same author gives the following formula for

GLYCERINE STAMP INK.

Aniline water-blue 1 B	3 drachms.
Distilled water	10 "
Acetic acid	2 "
Alcohol	1½ ounces.
Glycerine, enough to make	10 "

Make a solution by rubbing in a mortar. In the same way inks of the following colors may be prepared with the above compound menstruum, substituting, of course, the pigment named for the aniline water-blue in the formula given:

Violet: Methyl-violet (3 B)	2 drachms.
Red: Diamond fuchsin (I)	2 "
Green: Aniline green (D)	4 "
Brown: Vesuvin (B)	5 "
Black: Deep black (E)	3 "

For bright red omit the acid from the solution, replacing it by water, and using three drachms of eosin (B B N).

Coloring for Soda Sirups.—For the so-called sarsaparilla sirup caramel is used, and this may also be employed, of course, in coloring other "fancy" sirups, where a dark appearance is desired. This is obtainable in the market at moderate prices, but may be readily prepared if a dish of metal is at hand, preferably a copper one. Into such a dish any convenient quantity of refined sugar which will not fill it, say to more than half its capacity, is placed and about five ounces of water added for each pound of sugar. Heat is applied and raised to a sufficient degree to convert the sirup first formed into a black pitch-like mass, the mixture being well stirred meanwhile. More water is now added—about a pint for each pound of sugar taken; this addition must be made slowly to prevent the mixture frothing too much. Finally, heat is again applied, and the mixture stirred until solution of the caramel is effected; and in this form it is kept for use. A fine red color may be given to sirups by black cherry juice or black raspberry juice, and these are, of course, unobjectionable, if free from antiseptics. A red color may also be given by the cochineal coloring of the National Formulary, which is made as follows:

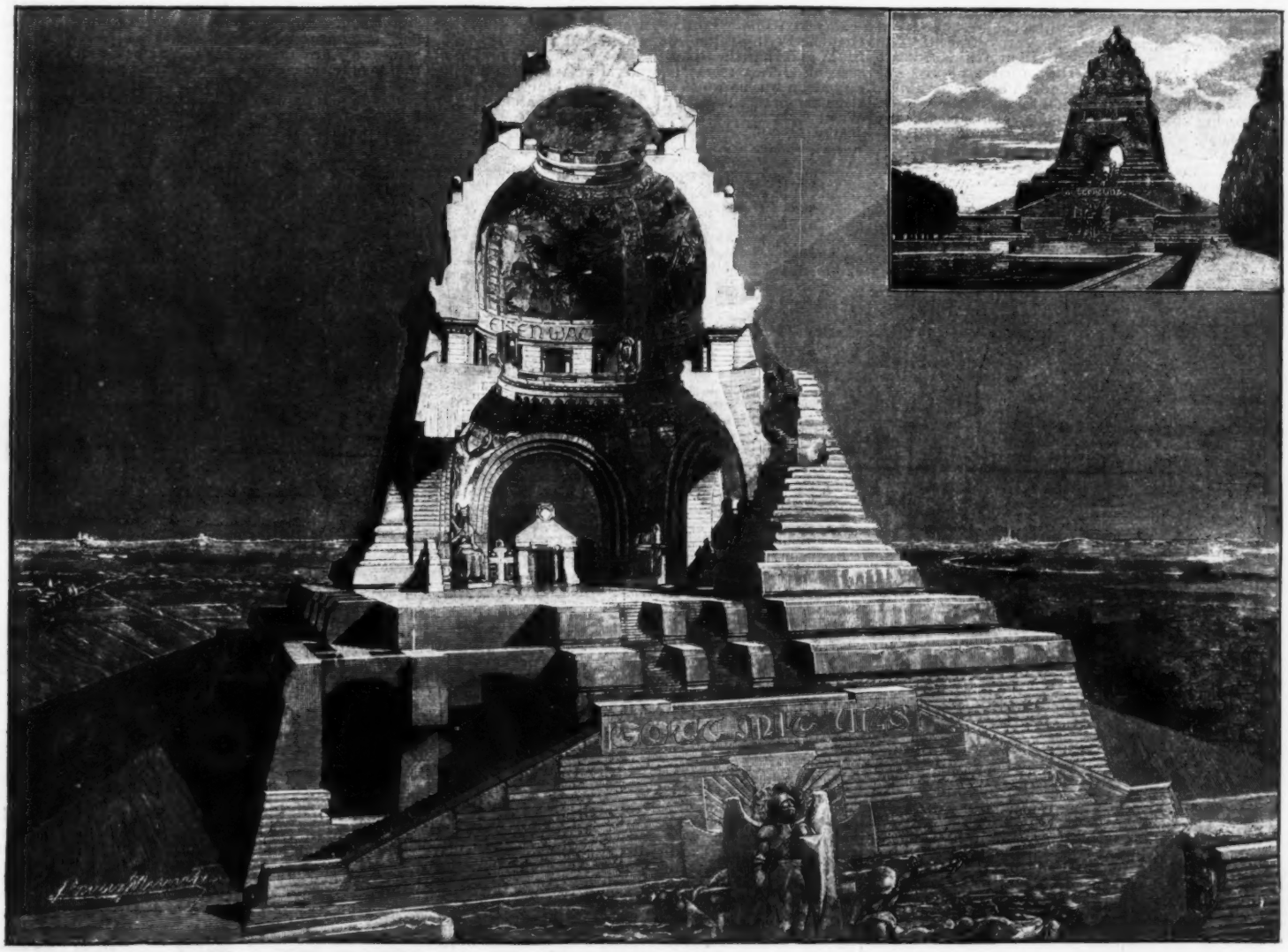
Cochineal, in No. 50 powder	60 grammes.
Potassium carbonate	30 "
Alum	30 "
Potassium bitartrate	60 "
Glycerine	500 c. c.
Alcohol	30 "
Water, a sufficient quantity to make	1,000 "

Triturate the cochineal intimately with the potassium carbonate and 500 c. c. of water; then add the alum and potassium bitartrate successively, heat the mixture to boiling in a capacious vessel, set aside to cool, add to it the glycerine and alcohol, filter, and pass enough water through the filter to make 1,000 c. c. Yellow may be obtained by infusing safflower in water. No anilin colors whatever should be used in coloring any preparation for internal use, as they are liable to be harmful in themselves, and also in many instances to be contaminated with poisons used in the processes of making them.—Druggists' Circular.

MONUMENT IN COMMEMORATION OF THE BATTLE OF LEIPSIC IN 1813.

THE erection of a great monument near Leipsic in commemoration of the terrible battle fought there in October, 1813, is specially commendable in view of the fact that the successes of the German army in France in 1870–71 have tended to put this struggle of the people (the Völkerschlacht, as the Germans call it) out of mind, although German strength and freedom date from this battle, in which so many were killed. Many small monuments have already been erected on those parts of the battlefield where the fight was hottest, and there is also a column on the so-called "Monarchenhügel," the hill on which the three monarchs are supposed to have met at noon on October 18; but as yet there is no truly impressive monument worthy of the occasion, although one has been much desired by Germans, and especially by the inhabitants of Leipsic. Now, however, a fine one is to be erected, and after carefully considering numerous plans and designs, the committee has accepted those of the architect, Prof. Bruno Schmitz, of Berlin. The monument is to stand almost in the center of the battlefield on a slight elevation of ground, so that its galleries will command a fine view of the place where Napoleon's army was defeated by the combined forces of Germany, Austria, and Russia.

Prof. Schmitz has treated the subject in a masterly manner. His architectural monuments — we recall now only the one on the Kyffhäuser—are wonderfully expressive of strength and pride. The new monument will be as massive as if intended to last forever, and its grandeur will not be disturbed by anything superfluous or frivolous. Everything about the design is bold and full of power. It will rise from a colossal base and will be approached by steps. The interior, which is to be divided into sections, will be decorated by paintings and sculpture which shall speak in a grand and simple language of the German emperors, the heroes of the war for freedom, patriots, and poets. Suitable inscriptions on the frieze will remind the Germans that the Fatherland and freedom are their greatest blessings. When the monument in memory of the Völkerschlacht is completed, it, with the monuments on the Kyffhäuser and the Niederwald, will form a triumvirate such as no other land can boast of.—Illustrirte Zeitung.



MONUMENT IN COMMEMORATION OF THE BATTLE OF LEIPSIC.—FROM THE DESIGN OF PROF. BRUNO SCHMITZ.

THE GERMAN MANEUVER FLEET IN A STORM ON THE BALTIC.

IN the latter part of August of this year the German Maneuver Fleet encountered some very severe weather on the Baltic Sea. The entire fleet, consisting of the "Kurfürst Wilhelm," "Brandenburg," "Weissenburg," "Wörth," "Baden," "Baiern," "Oldenburg," "Aegir," "Odin," "Hagen," "Heimdall," "Siegfried," and "Beowulf," with the "Greif," "Blitz," "Pfeil," "Hela," "Pelikan," five division boats, twenty-five torpedo boats, and the flagship of the commanding admiral "Blücher," steamed out of the Neufahrwasser into the narrow channel between Darsserort and the Gjedfer Reef, where the storm became so severe that the torpedo boats were ordered to seek shelter under the land, which they did, but not without suffering considerable damage, and torpedo boat "S 85" sank near Fehmarn. Our engraving shows the flagships of the several divisions struggling with the elements. The "Kurfürst Friedrich Wilhelm," flagship of the 1st division of the 1st squadron, is in the foreground, at the left we have the "Baden," flagship of the 2d division of the 1st squadron, and at the right the "Aegir," flagship of the 1st division of the 2d squadron, all under steam; while the dispatch boat "Hela," the newest vessel of the German navy, is plowing through the waves on the port side of the "Kurfürst Friedrich Wilhelm," with her bow buried deep in the water.

MANUFACTURE OF ALBUMEN AT CHINKIANG.

AN enterprising German firm has undertaken the manufacture of albumen at Chinkiang, China, it having been found that this place offered the best field for the business on account of the cheapness and plentiful supply of eggs. The factory is now successfully established, with possibilities of conducting it on a much larger scale.

United States Consul A. C. Jones, at Chinkiang, reports that the country surrounding Chinkiang has always been noted for the raising of ducks and other domestic fowls and much attention is given by the farmers to this industry. It is not an unusual thing for a farmer to have four and five thousand ducks under his care, and they may be encountered any day in a walk of a mile or two, marshaling their ducks in battalions of well drilled ranks to graze on the luxuriant grasses of the neighboring hills or to swim in the numerous ponds and watercourses.

In China the duck is a fine, large, hardy bird, a prolific layer, and requiring little attention and less expense, as she can readily find her food for herself. The egg of the duck is preserved by the Chinese by a process which will keep them when so preserved ten and twenty years. It is a favorite food of the people, especially of the higher classes, and is to be met with at all their dinners and entertainments. Ducks are sold in the market for about 30 cents (Mexican) a pair, and the eggs at about 6 cents a dozen.

The establishment of this albumen factory has made a good market for the eggs, and the country people bring them in by thousands. The factory uses duck eggs in the manufacture of albumen in preference to chicken eggs, solely on account of their greater cheapness. They are bought, not by the dozen, but by the thousand, the factory paying an average of $8 (Mexican) per thousand. The process of the manufacture of albumen is by no means new, but has not heretofore been a financial success, owing to inability to utilize the yolk as well as the white of the egg. This difficulty has now been successfully overcome. As the present capacity of this factory is forty thousand eggs per day, with an early prospect of a considerable increase on the introduction of machinery, it may be assumed that the farmers are greatly benefited by the establishment of this new industry.

As soon as the eggs are received at the factory, they are tested by a very simple but ingenious process. They are held in pairs in front of a circular opening in a tin cylinder open at the top, containing a lamp giving a powerful light, which is concentrated on the opening. Every speck and flaw in the egg is distinctly seen in this process, and all eggs showing the slightest sign of defect are at once rejected. The percentage of rejected eggs is remarkably small, rarely amounting to fifty per thousand. The good eggs are sent to the rooms prepared to receive them, where a number of Chinese girls are employed to break them and to separate the yolk from the white, placing each into separate vessels. The white then undergoes one of two processes—it is either carefully cleaned of all stray clots of yolk and then put through a course of stirring in a large vessel by means of a heavy rod or paddle worked by hand, when it is ready for the drying room; or, after being cleaned, it is run into large vats and allowed to ferment, the process of fermentation being accelerated by the admixture of certain chemicals, which chemicals, by the way, are held by the firm as a secret. When it is found in drawing off that all impurities have either been deposited or thrown off in the form of a thick froth, and the resulting liquid is albumen, as clear as water, the albumen is ready for the final process of drying. This is performed in a series of three rooms, each hotter than the last, the temperature ranging from 40° to 50° Centigrade. The albumen is run into shallow tin pans about a foot square, which are placed in ranges of shelves in the drying rooms. Frequent examinations are made to see that the temperature is maintained, and that the process of drying is sufficiently gradual, uniform, and complete, a period of sixty to seventy hours being found necessary for that purpose. When thoroughly dry the albumen, which now presents the appearance of isinglass with a yellow tinge, is, after cooling, placed in large, square packing boxes, lined with tin, holding about 400 pounds each, and is ready for shipment.

The principal use for albumen is in the preparation of fast dyes for superior kinds of cotton goods, and it is shipped to England, Germany, and France.

An inferior kind of albumen, I am informed, is manufactured in the United States from bullock's blood and used for inferior goods.

The yolk of the eggs, after separation from the white, is passed through two sieves—one coarse and one fine—and is then run off into vessels holding about 20 pounds each, in the form of a yellow, even-running liquid of the consistency of rich cream. It is then poured into vats holding about 100 pounds, and a 10 per cent. solution of salt, borax, and an unrevealed chemical is then added for the purpose of preservation. The mixture is thoroughly stirred until it assumes the consist-

ency of thick molasses and of a dark orange color, and is then poured, or, rather forced, through a funnel into a cask holding about 500 pounds net. It is then ready for shipment. This is used in the preparation and dressing of superior leather goods, and is in much demand in England, Germany, and France.

No use has yet been found for the empty egg shells, and they are thrown away.

OFFICIAL REPORT ON THE NAVAL OPERATIONS IN THE WEST INDIES.

SECRETARY LONG has just made public the official report of Rear-Admiral Sampson's fleet, which describes the naval operations before Cuba which ended in the destruction of Cervera's fleet. It is an exhaustive report and contains many items of interest which will appeal to all naval men and to those who have closely followed the operations of the fleets. The report is in the form of a running diary of events which took place from May 4 to July 2, so that it covers the anxious work of almost two months which culminated in the total destruction of the squadron of Admiral Cervera. The report is accompanied by a chart prepared by Rear-Admiral Sampson which shows the movement of the warships under his command. This chart we reproduce. The solid lines show the movements of the North Atlantic Squadron under the command of Rear-Admiral Sampson and the double dotted line the squadron of Admiral Cervera; the single dotted lines starting out from Key West show how Commodore Schley's Flying Squadron was moved, and its position at a given hour each day is also indicated. His course can be followed to Cienfuegos and thence to Santiago. Commodore Schley's movements to the westward and thence back to Santiago are also easily traced. The various movements of the North Atlantic Squadron are also indicated until finally they turn around Cape Maysi and join the Flying Squadron before Santiago. The arrows indicate the direction taken by the vessels. The following notes are a chronological abstract of the Report, which is too long for reproduction in toto:

May 4.—The North Atlantic Squadron started from Key West and from in front of Havana, it having been decided upon information received April 29 that Admiral Cervera's squadron had sailed from the Cape Verde Islands. The Department ordered that a squadron should go into the Windward Passage for the purpose of observation, with a view to going further east, if thought desirable. The monitors were taken in tow, and Rear-Admiral Sampson reports: "This was the beginning of our experience with the inefficiency of the monitors. Their coal supply was so small that it was at once evident that they must frequently coal or they must be towed. Therefore, the 'New York' took one of the monitors in tow, and the other was towed by the 'Iowa.' There was endless trouble and delay from the breaking of tow lines, etc. At the first opportunity, when the sea was sufficiently smooth, the monitors were given coal from the 'Niagara' and again taken in tow. Had the sea been rough or had the enemy appeared at this juncture, the squadron would have been in a much better position for an engagement had the monitors been elsewhere. Subsequently, when engaging the batteries at San Juan, it was evident that their shooting was very bad. Owing to the quick rolling of these vessels, even in a very moderate sea, they were unable to fire with any degree of accuracy."

May 6.—The "Montgomery" was sent ahead to call at Cape Haitien for telegrams, and five telegrams were received from Secretary Long; one gave orders not to engage the vessels against fortifications, so that they could afterward successfully fight the Spanish fleet. Information was given that the "New York," "St. Louis," and "Paris" were on the lookout for the Spanish vessels.

May 8.—All the commanding officers were called aboard the flagship, and a consultation regarding the situation was held. Rear-Admiral Sampson decided to stand to the eastward as far as San Juan, Porto Rico, on the chance of finding the Spanish squadron in that port, where, if he was not successful in destroying it, he could at least blockade and hold it.

The squadron stopped twenty miles north of Cape Haitien on the coast of Hayti, and the afternoon of the 8th and the morning of the 9th were spent in coaling the monitors and gunboats.

May 9.—A dispatch was received from Washington stating that the "Pelayo" and the "Carlos V." had not left Cadiz, but that the other vessels were seen on May 7 near Martinique. The dispatch went on to say: "The blockade of Cuba and Key West will be injured if stripped by you. You should be quick in your operations at Porto Rico."

May 12.—The squadron arrived off San Juan and the bombardment of that place began at 5:10 o'clock and ended at 7:45. It was soon seen that Cervera's fleet was not in the port. Rear-Admiral Sampson says: "It was clear to my own mind that the squadron would not have any great difficulty in forcing the surrender of the place, but the fact that we should be held several days in completing arrangements for holding it; that part of our forces would have to be left to await the arrival of troops to garrison it; that the movements of the Spanish squadron, our main objective, were still unknown; that the Flying Squadron was still north and not in a position to render any aid; that Havana, Cervera's natural objective, was thus open to entry by such a force as his, while we were a thousand miles distant, made our immediate movement toward Havana imperative. I thus reluctantly gave up the project against San Juan and stood westward for Havana."

May 13.—News was received from a newspaper dispatch boat that Admiral Cervera's squadron had returned to Cadiz. The next day messages were sent to Washington asking for the confirmation or denial of these reports. These telegrams had in view the return to and capture of San Juan.

May 15.—The "Porter" brought dispatches saying that the Flying Squadron would sail for Charleston, S. C., and that the Spanish Cape Verde fleet had been seen off Curaçoa May 14, and later that the Flying Squadron was en route to Key West, and gave directions to proceed with all possible dispatch to Key West.

May 16.—The "Porter" arrived at the rendezvous with the dispatches from Curaçoa stating that the vessels had been seen there and that they were short of coal and provisions and that their bottoms were dirty. Orders were at once sent by Rear-Admiral Sampson to the blockading vessels off Cienfuegos that the Spanish fleet might appear at any time on the south coast of Cuba.

May 17.—The flagship, then in the Bahama Channel, left the squadron and proceeded with all speed to Key West. She was met by the "Dupont" with dispatches from the Department, stating that it had just heard that the Spanish fleet had munitions of war essential to the defense of Havana, and the order of the Spanish fleet was imperative to reach Havana, Cienfuegos, or a railroad port connected with Havana at all hazards; and as Cienfuegos appeared to be the only port fulfilling the conditions, Commodore Schley had arrived at Key West on the morning of the 18th to be sent at once to Cienfuegos; so the dispatch directed Rear-Admiral Sampson to send his most suitable armored ship to join Schley and hurry with the remainder of his heavy ships to the blockade before Havana.

May 18.—Rear-Admiral Sampson arrived at Key West at 4 P. M. and found Commodore Schley, with the "Brooklyn," "Massachusetts," "Texas," and "St. Paul," anchored in the outer roads. He was urged by a telegram from the Department to use the utmost dispatch to get the force off for Cienfuegos. The coaling of all the ships was proceeded with with all dispatch.

May 19.—About 9 o'clock Commodore Schley sailed with the "Brooklyn," "Texas," "Massachusetts," and "Scorpion" for Cienfuegos with instructions from Rear-Admiral Sampson to establish a blockade at Cienfuegos with the least possible delay, and if the Spanish fleet should attempt to come around the island, either east or west, to send him (Sampson) notice by the best vessel as to their direction, so that he would be prepared for them at Havana.

May 20.—The "Iowa" got under way with the "Castine" and "Merrimac" for Cienfuegos. The movements of the vessels may now be studied by reference to the chart.

On the same day the Rear-Admiral telegraphed to the Department that he had directed Commodore Schley "to communicate with auxiliaries at Santiago and direct one of them to report to the Department from Mole St. Nicholas or Cape Haitien, then to return to Santiago and further report at Cienfuegos or Havana, as he thinks best. The plan may be changed when it becomes certain that Spanish ships are at Santiago." The Department also telegraphed Sampson that the "report of the Spanish fleet being at Santiago might very well be correct, and also that the army expected to have within a few days thirty transports at Tampa."

May 21.—Instructions were sent to Schley by Sampson by means of the "Marblehead." The dispatch said: "Spanish squadron probably at Santiago de Cuba. Four ships and three torpedo boat destroyers. If you are satisfied they are not at Cienfuegos, proceed with all dispatch, but cautiously, to Santiago de Cuba, and if the enemy is there, blockade him in port." Dispatches were also received on the same day from the "St. Louis" saying that one submarine cable to Jamaica had been destroyed. The flagship arrived off Havana, and feeling much concerned as to the early delivery of orders to Commodore Schley which were sent by the "Marblehead," the "Hawk" was ordered to carry a duplicate of the orders with additional memorandum asking him to leave before daylight, so that his direction would not be noticed and be at Santiago on the morning of May 24. He said: "If you arrive at Santiago and no scout meets you, send a vessel to call at Nicholas Mole and get information to be left there by the scout as to direction taken by the Spanish in case they may have left Santiago de Cuba. The 'Yale' has been ordered to cruise in the Bahama Channel until May 24. It is thought possible that the Spanish, hearing of your departure from Cienfuegos, may attempt to go there. If this does not reach you before daylight, it is suggested to mask your real direction as much as possible. Follow the Spanish squadron, whichever direction they take."

May 22.—Rear-Admiral Sampson received a telegram regarding coaling stations, etc., which ended by saying: "Orders are being sent placing Schley under your

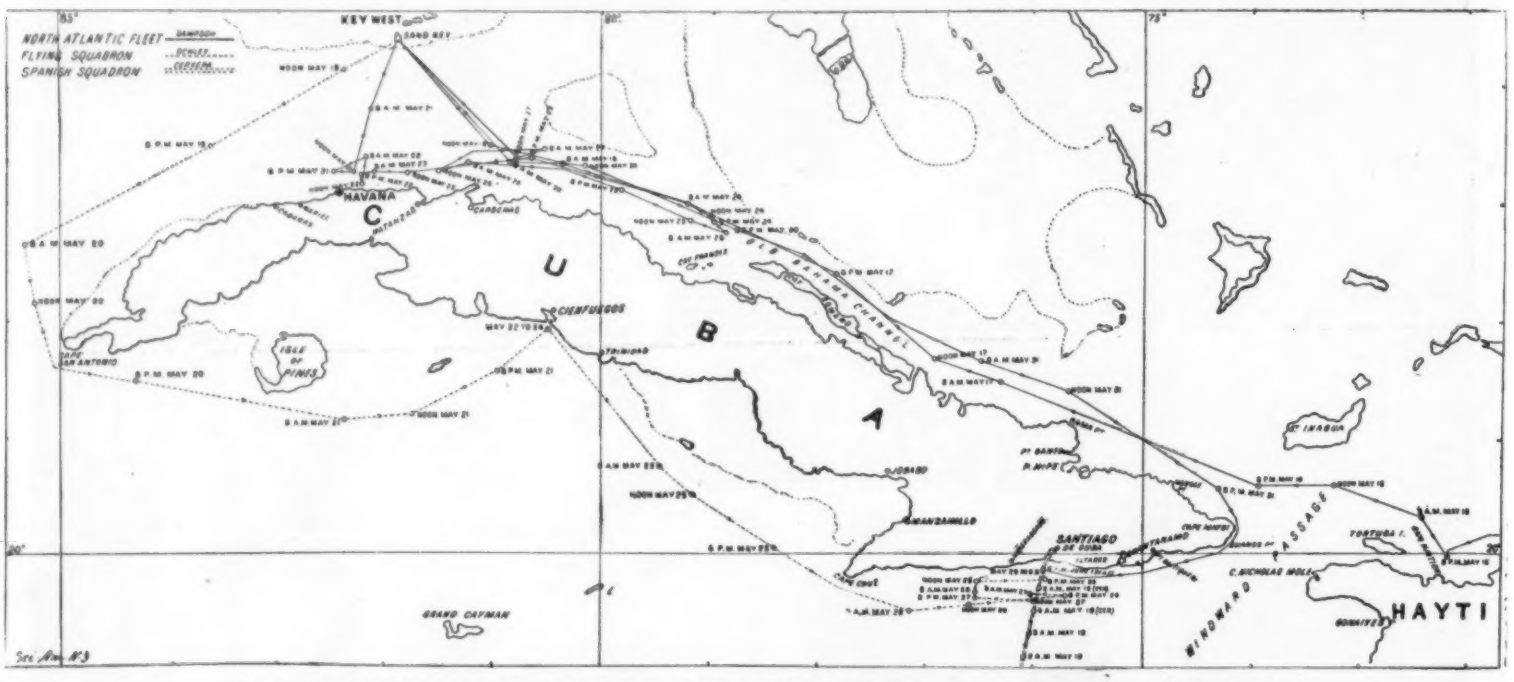
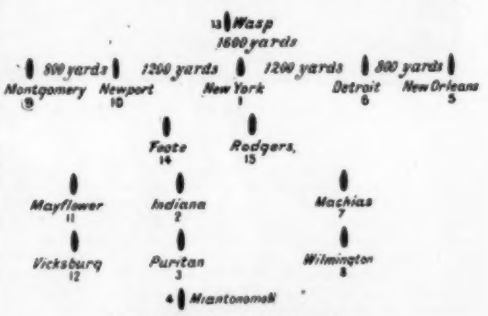


CHART OF THE NAVAL OPERATIONS PRIOR TO THE DESTRUCTION OF CERVERA'S SQUADRON.

command while in the West Indies." On May 23, the captains of all Rear-Admiral Sampson's fleet received their directions and a copy of the order of cruising,



ORDER OF CRUISING.

first order of battle, second order of battle, and third order of battle, from which the following is copied:

"Owing to the superior speed of the Spanish vessels, I have decided to form the ships in one column, heading to the eastward, on the assumption that the enemy will be proceeding to the westward in column. The 'New York,' 'Indiana,' 'Puritan,' 'Miantonomoh,' will be the four leading vessels. These will be followed by the cruisers of the blockading squadron, the idea being that the heavy ships should first meet the enemy and the fire of the cruisers be brought into play after the damage inflicted by the larger ships.

"The armored ships, after passing the rear of the Spanish squadron, will turn in succession by using the starboard or port helm, as the case may require, turning toward the enemy. It is believed that the fire of the cruisers, following that of the armored ships, will so embarrass the Spanish vessels that the armored vessels

can turn, as before stated, and double on the enemy's rear.

"The ships designated will assemble twelve miles northeast of the Morro at early daylight Monday, the 23d inst.; thence they will proceed in three columns to the eastward in the order of cruising designated. (See Plan 1, first order of cruising.)

PLAN I.—FIRST ORDER OF BATTLE.

"The 'New Orleans' will act as scout on the starboard hand, the 'Montgomery' on the port, the 'Wasp' ahead.

"When the enemy heaves in sight, the vessels will proceed to the eastward to meet them. While so doing they will be formed in column. (First order of battle.)

"The attention of commanding officers is called to the necessity of stopping these vessels.

"In the first order of battle the two torpedo boats will take station on the off side of the 'New Orleans'

PLAN II.—SECOND ORDER OF BATTLE.

and 'Detroit,' and, if there be a third, it will take its place on the off side of the 'Machias.' They will take advantage of any opportunity to torpedo an enemy's ship.

"While the 'Vizcaya,' 'Maria Teresa,' and 'Oquendo' have strong protection on barbettes and water line, they have no protection elsewhere, and are vulnerable to even 6-pounders. Fire to be concentrated on the center part of these ships just above water line. In case of 'Cristobal Colon,' her belt and barbette armor is inferior to that of the other ships, but her protection

PLAN III.—THIRD ORDER OF BATTLE.

elsewhere extends over a larger area. None of this armor is face-hardened. W. T. SAMPSON,
Rear-Admiral, Commander in Chief."

May 23.—The North Atlantic Squadron started eastward at low speed, the object being to occupy the Nicholas Channel in such a manner as to prevent the approach of the Spanish squadron from the east, but not to go so far as to make it impossible to fall back to Havana in case of their approach from the westward being signaled. This latter movement was thought possible, as by a southerly course it would have been well within the bounds of possibility for them to pass to the westward without its being known to Commodore Schley's squadron, which was supposed to be on its way to Santiago.

May 24.—Dispatches received by the North Atlantic Squadron indicated that the principal aim of the Spanish fleet was to introduce a supply of munitions of war and food by Havana and Cienfuegos. Another dispatch stated that until further instructions the division under Schley must not be diminished, as the Spanish division at Santiago must, if possible, be prevented from escaping. A dispatch which was received from the "St. Louis" stated that the cables were cut at Guantanamo. Great precautions were now taken regarding the showing of lights at night, the vessels being directed to keep near enough to follow each other with or without lights, whether the sea was foggy or clear.

May 25.—Instructions were received for the North Atlantic Squadron to be prepared to convoy and guard about 30,000 United States troops and 40 transports.

May 26.—The "Vesuvius" arrived from Key West with the dispatch from Commodore Schley stating that he arrived safely at Cienfuegos on May 21, where he found the Spanish engineers mining the harbor. He said he was unable to tell whether the Spanish fleet was in port or not, and he expected great difficulty in coaling from the colliers on account of a constant heavy swell. The "Vesuvius" was sent to Key West with dispatches for the commanding officers of the "Yale," "Minneapolis," and "St. Paul," which said: "Spanish squadron is at Santiago. If Schley has not arrived, go to Cienfuegos and inform him." At 9:30 of this day the "Dolphin" came alongside of the North Atlantic Squadron with dispatches and reported that Commodore Schley had the Spanish squadron bottled up at Cienfuegos. The reason for believing this to be the case was two letters from Commodore Schley dated May 23, in which it was stated that the large amount of smoke seen in the harbor would indicate the presence of a number of vessels, and under such circumstances it would be extremely unwise to chase up a probability at Santiago reported via Havana no doubt as a ruse. The steamer "Adula" reached Cienfuegos on May 23. She reported that she left Santiago on May 18, and on that night she saw the lights of seven vessels seventy miles to the south of Santiago. The next day, May 19, the Kingston cable reported the Spanish fleet at Santiago, and on May 20 the fleet was reported to have left Santiago, and on May 21 Commodore Schley heard from the bridge of his flagship, when about forty miles southwest of Cienfuegos, a firing of guns toward Cienfuegos, which he interpreted as a welcome to the Spanish fleet, and the news by the "Adula" confirmed him in his belief.

May 27.—Sampson sent Schley a dispatch which said: "Every report, and particularly daily confidential report received at Key West from Havana, states Spanish squadron has been in Santiago de Cuba from the 19th to the 25th inst. inclusive, the 25th being the date of the last report received. You will please proceed with all possible dispatch to Santiago to blockade that port. If on arriving there you receive positive information of the Spanish ships having left, you will follow them in pursuit." The same day Rear-Admiral Sampson also received copies of telegrams from Commodore Schley to the Department dated May 24, in which he complained of great difficulty in coaling and also of the "Texas'" short coal supply and her inability to coal in the open sea. Schley says: "I shall not be able to remain off that port, on account of general short coal supply of squadron, so will proceed to the vicinity of Nicholas Mole, where the water is smooth and I can coal "Texas" and other ships what may remain in collier. Will communicate with you from Nicholas Mole." Rear-Admiral Sampson says: "I at once decided to go to Key West, coal, and if authorized by the Department, proceed to Santiago."

The "New Orleans" was given orders to proceed with the best dispatch to Santiago with the collier "Sterling," with orders for Commodore Schley. This order read: "You will communicate with Commodore Schley and direct him to remain on the blockade at Santiago at all hazards, assuming that the Spanish vessels are in that port, and tell him that I desire that he should use the collier 'Sterling' to obstruct the channel at its narrowest part leading into this harbor. Inform him that I believe it would be perfectly practicable to steam this vessel into position and drop all her anchors, allow her to swing across the channel, then sink her, either by opening the valves or whatever means may be best in his judgment."

May 28.—The Rear-Admiral arrived at Key West and found the "Oregon" in the harbor outer anchorage. A telegram was at once sent in cipher to Commodore Schley, stating that the "New Orleans" would meet him off Santiago on May 29, with important dispatches; and it further said: "The Spanish squadron must be blockaded at all hazards. Immediate communications with persons on shore must be entered upon. You must be sure of the Spanish squadron being in port. I suggest communicating with Spanish American Company, at Daiquiri, but at a distance of fifteen miles east from Santiago de Cuba. One collier for you left yesterday. Shall send another as soon as possible. If Spanish squadron has left Santiago, immediate pursuit must be made."

The Rear-Admiral also sent a dispatch to the Department, in which he states: "Schley, not being satisfied that the Spanish squadron was not in port, did not go."

The Department has his dispatch, dated May 24, stating his intention of leaving on May 25. "I do not understand this delay until next day."

The Department also notified him that: "If the Spanish division is proved to be at Santiago, it is the intention of the Department to make descent immediately upon that port with 10,000 United States troops," and that the Rear-Admiral would be expected to convoy the transports in person with the "New York," "Indiana," "Oregon," and smaller vessels. About midnight the Rear-Admiral received the following telegram from the Department:

"Schley telegraphs from Santiago de Cuba he goes to Key West with his squadron for coal, though he has 4,000 tons of coal with him in a broken down collier. . . . Schley has not ascertained whether the Spanish division is at Santiago. All information here seems to show that it is there."

May 29.—Rear-Admiral Sampson telegraphed to the Department: "The failure of Schley to continue the blockade must be remedied at once, if possible. There can be no doubt of the presence of the Spanish squadron at Santiago." He also received a telegram from Commodore Schley, which asked whether he should endeavor to coal the "Marblehead" and "Texas" in the open sea and retain position off Santiago until a larger coal supply could be obtained. The dispatch stated that, on May 27, the "Marblehead" and "Texas" took a quantity of coal at a distance of twenty-five miles west of Santiago, which enabled them to hold the place until the stock of coal had been reduced.

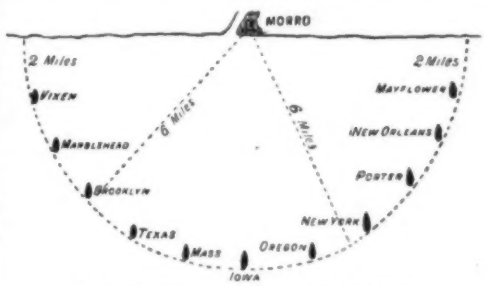
Here follows a break in the official telegrams; but the inference is that the vessels would probably have to go over to Hayti to replenish their coal supply. Telegrams were at once sent to the Secretary of the Navy, stating that Schley was blockading Santiago, and would continue to do so until coal supply had been reduced to a safe limit for large ships. The following telegram was sent to Commodore Schley by Rear-Admiral Sampson: "Congratulate you upon success. Maintain close blockade at all hazards, specially at night. Very little to fear from torpedo boat destroyers. Coal in open sea whenever conditions permit. Send a ship to examine Guantanamo, with view to occupying it as base, coaling one heavy ship at a time." Authority was also given him to proceed to Santiago.

May 30.—The "New York" left Key West for Santiago, and the "Oregon," "Mayflower," and "Porter" were also taken up. The "St. Paul" and the "Yale" were also met standing westward under orders for Key West for coal. A commanding officer of the "St. Paul" gave Rear-Admiral Sampson copies of dispatches from Schley, in which was given the good news that Schley had recognized the "Cristobal Colon" and "Infanta Maria Teresa" and two torpedo boats inside Morro, at the entrance of Santiago Harbor. The Flying Squadron was at this time composed of the "Brooklyn," "Iowa," "Massachusetts," "Texas," "Marblehead," "Vixen," and a collier.

May 31.—Sampson sent a dispatch to the Secretary of the Navy by way of Mole, St. Nicholas, stating that he would reach Santiago the next day.

June 1.—Rear-Admiral Sampson arrived off Santiago and found Commodore Schley's squadron in column to the westward of the mouth of the harbor. The squadron was composed of the following vessels: "Brooklyn," "Iowa," "Massachusetts," "Texas," "New Orleans," "Marblehead," "Harvard," "Vixen," "Merrimac" and "Sterling." The same day a dispatch was received from Secretary Long, stating that it was essential to know if all the four armored cruisers were at Santiago, as the military expedition must wait for this information. This dispatch stated that the army was embarking at Tampa, Florida. Immediately on arrival, Rear-Admiral Sampson steamed down past the entrance to Santiago Harbor and saw lying close within the "Cristobal Colon" and one of the "Vizcaya" class. Both of these vessels got up steam and moved up into the harbor out of sight. Preparations were at once made to sink the collier "Merrimac" in the entrance, the night of this day being particularly favorable for the enterprise. "In consulting Assistant Naval Constructor Hobson," says Rear-Admiral Sampson, "as to the best means of sinking the vessel, he showed himself so interested, worked to such a degree in the preparation and entreated so strongly that he might be allowed to take the ship in that I consented, though several hundred officers and men had volunteered and many begged hard to go." Assistant Constructor Hobson had formerly been a line officer and was for some time assistant navigator of the "Chicago," so that he was qualified to conduct the ship.

June 2.—Unfortunately, the preparations were not completed by daylight of the second, and the expedition had to be postponed to the next night. June 3.—3:30 A. M., the "Merrimac" went in and was sunk. As we now know, she did not sink until she was much higher in the channel than was intended. This was owing to the failure of her steering gear and to a partial failure of the torpedoes arranged along her side to explode. The order of battle was as follows: The first squadron, under the personal command of Rear-Admiral Sampson, was composed of the "New York," "Iowa," "Oregon," "New Orleans," "Mayflower" and



DAY AND NIGHT FORMATION.

"Porter." The second squadron, under the command of Commodore Schley, was composed of the "Brooklyn," "Massachusetts," "Texas," "Marblehead," and "Vixen." The vessels were directed to blockade Santiago closely, keeping out six miles from Morro in the daytime and closing in at night, the larger vessels well in shore. The first squadron blockaded the east side of the port, the second squadron the west side. Rear-Admiral Sampson said: "If the enemy tries to escape, the ships must close and engage as soon as possible and endeavor to sink his vessels or force them to run ashore in the channel. It is not considered that the shore batteries are of sufficient power to do any material injury to the battleships. In smooth weather the vessels will coal at station. If withdrawn to coal elsewhere or for other duty, the blockading vessels on either side will cover the angle thus left vacant."

June 3.—The "St. Louis," "Yankee," and the collier "Justin" arrived. The "St. Louis" brought dispatches from Mole St. Nicholas which gave news as to cables, to the Spanish vessels navigating in Cuban waters, that the "Terror" had been damaged at San Juan and that General Shafter was ready to start on June 14 with 18,000 troops. About 3 P. M. the Spanish tug "Colon" came out of Santiago Harbor flying the flag of truce, and the "Vixen" was sent to meet her. The Spanish captain came on board with a letter from Admiral Cervera announcing the safety of the "Merrimac's" crew. Toward midnight the "Mayflower" left for Key West, carrying telegrams to the Secretary of the Navy describing the sinking of the "Merrimac" and the safety of her crew. The dispatches also announced that four Spanish armored vessels and two torpedo boat destroyers had been seen in the harbor.

June 4.—Another order of battle was issued in which the "Texas," "Massachusetts," "Iowa," and "Oregon" were ordered to take positions 4,000 yards from Estrella Point and opposite the entrance to the port of Santiago, in the order named, from west to east, in such position as to be able to observe the wreck of the "Merrimac," and they were ordered to fire upon any parties that might be seen working upon it. If fire be opened by the batteries, it was to be returned and endeavor made to destroy them. It was ordered that

firing on Morro was to be avoided, as the men from the "Merrimac" were confined there.

June 5.—Another order of battle was also issued by the Admiral. The western column heading north was to be composed of the "Brooklyn," "Marblehead," "Texas," and "Massachusetts." The east column heading north to be composed of the "New York," "Yankee," "New Orleans," and "Iowa." The vessels were ordered to be 400 yards apart and to retain that position, the west column using the starboard battery, the east column the port battery.

June 6.—At 6:30 A. M. the vessels formed two columns as according to the "order of battle" above. At 6:43 "general quarters" was signaled and the ships stood in toward the battery. At 7:38 the signal "commence firing" was given. The first fire was opened at 7:41, the range being 6,000 yards. At 8:05 "cease firing" was given. General firing was then discontinued, but individual firing at a slow rate of speed was continued until 9:40. At 10:08 the signal to "resume blockading stations" was given. In the afternoon dispatches were sent by way of Mole St. Nicholas giving news of bombardment of the forts, and a number of telegrams were also received from Washington, one of which was a congratulatory telegram stating that the Department highly appreciated the heroic conduct of Hobson and asking for recommendation for advancement.

June 7.—Nothing of importance occurred.

June 8.—Orders were also issued concerning the use of search lights. Telegrams were also received from Washington giving news that the military expedition was almost ready to start. The "Yankee" was sent to Mole St. Nicholas with dispatches stating that on the previous day the "Marblehead" and "Yankee" had arrived at Guantanamo. They entered the harbor, taking possession of the lower bay, immediately after their arrival, driving back a small gunboat to the protection of the submarine mines. All communication between Cuba and the outside world was cut off by the destruction of the cables. The Rear-Admiral urged the sending of the military expedition. The difficulty of blockading the port increased daily. It was also requested that the "Vesuvius" be sent to Santiago.

June 9.—Nothing of any importance transpired.

June 10.—The "Panther" was sent to Guantanamo in company with the "Yosemite."

June 11.—The Marine Battalion was landed safely and established in camp. The "St. Louis" arrived with the British steamer "Twickenham," a collier which she captured off Jamaica. The "St. Louis" was sent to Mole St. Nicholas with dispatches to the Secretary of the Navy relative to the exchange of prisoners and a resumé of a letter from General Garcia to Major-General Miles, which gave information as to the strength of the insurgents and their good will and their desire to co-operate with the United States army. An order was also issued regarding search lights. It seems that the search light practice was very bad at first, but under specific orders from Rear-Admiral Sampson it improved greatly.

June 12.—The torpedo boat "Porter" arrived from Guantanamo and brought a report from Commander McCalla, stating that on the previous day a scouting party had been attacked by the Spaniards and that one sergeant and two privates were killed. Dr. Gibbs was killed in the camp.

June 13.—The "Vesuvius" arrived after scouting in the Bahama Channel, the "St. Paul" from New York, and the "St. Louis" from Mole St. Nicholas. A dispatch was sent by the "St. Louis" announcing the return of Lieutenant Blue, after a detour of seventy miles, to observe the inside of Santiago Harbor. He reported that the Spanish squadron was all there.

June 14.—The "Vesuvius" went inshore and fired three shots, and just after daylight the "New Orleans" was ordered in and engaged the battery to the east of Morro, with the idea of preventing a continuation of work and the replacing of guns which might have been dismounted. She soon became actively engaged with both batteries and fired with accuracy and effectiveness for about twenty minutes. The attack on behalf of the marines at Guantanamo continued, and other men were killed.

June 14.—A force of marines attacked the enemy, who were routed. The bodies of four of the marines were found and two officers and fifteen Spanish privates were captured. The blockhouse was partially destroyed and a heliographic apparatus was also captured. Our loss was slight, being two Cubans killed, four wounded, and two marines wounded. The enemy was reinforced by troops from Caimanera, and the "Texas" and "Suwanee" were consequently sent to destroy the fort and capture the gunboat used in transporting the men. This was done the next day with the aid of the "Marblehead." The order of battle was also modified by Rear-Admiral Sampson.

June 15.—The fort in Guantanamo Bay was destroyed by the "Texas," "Marblehead," and "Suwanee."

June 16.—The batteries to the east and west of the entrance to the harbor were bombarded at early dawn. They were quickly silenced and fire was continued half an hour.

June 17.—A number of dispatches were received and sent. A deserter from the "Reina Mercedes" stated that the "Merrimac" did not block up the channel, she being too far up the harbor. Rear-Admiral Sampson strongly urged the army to move with all possible celerity, as the fine weather might end at any time. An important letter from Guantanamo to Spanish commanding officers at Santiago, which was intercepted, reported that there was only a small quantity of food, not more than sufficient for the month of June.

June 19.—Rear-Admiral Sampson received news that the ships which were to convoy the troops consisted of the "Indiana," "Detroit," "Bancroft," "Helena," "Annapolis," "Wasp," "Eagle," "Hornet," "Osceola," "Manning," and "Ericsson." News was also given of the intention of the President to establish a blockade to cover the ports of Cuba from Batabano to Cape Cruz. Rear-Admiral Sampson sent a telegram to the Secretary of the Navy stating that Cienfuegos was already blockaded by the "Yankee" and Cape Cruz and vicinity by the "Dixie." He also announced that all foreign cables had been cut, the last one on the 18th. On the same day Rear-Admiral Sampson and his chief of staff went down to Aserraderos in the "Vixen" to examine the facilities for landing at that point. He returned, bringing with him General Garcia, General Lora, and several officers of their staffs. Valuable information was obtained as to the disposition of the Spanish forces and the strength of the insurgents.

June 20.—The fleet of transports of the Fifth Army Corps and its convoys arrived at a point fifteen miles to the southward, and Rear-Admiral Sampson at once sent his Chief of Staff in the "Gloucester" to communicate with Major-General Shafter. Sampson and Shafter went to Aserraderos, where they had an interview with General Garcia, and a landing was arranged for at Daiquiri.

June 21.—The cable at Guantanamo was connected with that of Mole St. Nicholas, and an office opened there for general telegraphic use. Rear-Admiral Sampson issued elaborate orders of battle.

June 22.—Rear-Admiral Sampson received word from Major-General Shafter that the latter would begin landing his troops that morning. Fifty steam launches and cutters were furnished from the ships of the squadron and the landing began during the forenoon. The "New Orleans," "Castine," "Detroit," and "Wasp" covered the landing. When the first detachment of boats were ready to go ashore a brisk fire was opened against Daiquiri, but there was no return. The Spanish troops evacuated the place and fell back without, as far as is known, firing a shot. During the landing at Daiquiri there was a feint made at Cabanas and points west. The "Texas," lying off Cabanas, engaged the Socapa battery during a period of about two hours. She was struck by one shell, one man being killed and eight wounded. About 7,000 men were landed during the day. Siboney was also occupied by our forces and troops were also disembarked there.

June 23.—Under flag of truce, Rear-Admiral Sampson learned that Hobson and his men were all well and confined in the city of Santiago, at a distance of four miles from Morro.

June 24.—Nothing of any importance transpired.

June 25.—A force was sent by Commander McCalla to determine if the enemy still occupied the extremities of Punta del Jicacal, Guantanamo Bay. The landing flotilla consisted of boats and various ships towed by steam launches of the "Helena," "Annapolis," and "Bancroft." The boats advanced in three columns and the troops were landed quickly and quietly and a thorough reconnoissance was made of the point. The enemy was not seen and the men re-embarked. The "Marblehead" then proceeded to the channel between Jicacal and Cayo del Hospital to be dragged for mines. Four mines were found and successfully raised. This made thirteen mines in all raised in the channel.

June 26.—Rear-Admiral Sampson sent a telegram to the Department explaining the situation. He stated that in smooth water ships could coal off Santiago with some difficulty, but he regarded it as essential not to reduce this force too much, in view of the fact that the weather might compel the fleet to coal at Guantanamo. This telegram was sent with reference to the proposed detachment of some of the heavy ships for service abroad. He also stated in his telegram that the channel was not obstructed by the "Merrimac," and that the fleet must be prepared to meet the Spanish squadron if they attempted to escape. He also said he was preparing a torpedo boat attack in order to hasten their destruction. He stated that the present force would insure a capture which he believed would terminate the war. After events showed that he was fully justified in his views.

June 28.—Rear-Admiral Sampson was authorized to detain the "Oregon" and "Iowa" until the other armored vessels had been fully coaled, as it was intended to send them to the east via Spain.

June 30.—Sampson received notice from Major-General Shafter that he expected to attack Santiago on the next morning and asked him to bombard the forts at Aguadores in support of the regiment of infantry which he was going to send there, and also to make such demonstrations as he thought proper at the mouth of the harbor. July 1.—In accordance with this request the "New York," "Suwanee," and "Gloucester" took position off Aguadores at 6 A. M., and awaited the arrival of troops, which came by rail within a mile and a half of this point. They arrived at 9:30, and the vicinity was shelled by the three ships mentioned. A few men were in the rifle pits in the hill above the railway bridge, but they disappeared when the firing began. The corner of the fort was knocked off and the flagstaff was knocked down by the "Suwanee." Desultory firing was kept up by the Spanish from the wood adjoining the rifle pits, and about noon a small field piece was brought down the gorge and it was fired four or five times. The "New York," on observing this, enfiladed the gorge, firing several 8-inch shells and a number of 4-inch shells. No firing by the enemy was observed after this. The troops then returned to the railway station by which they had come and left for Siboney. The "New York" and "Oregon" then took up position and fired a number of 8-inch shells off the hills in the direction of Santiago and the ships in the bay, using a range of 3½ to 4 miles.

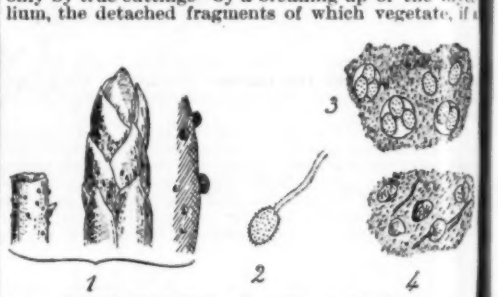
July 2.—Rear-Admiral Sampson received a dispatch from Major-General Shafter stating that he intended to assault at daylight, and requested the fleet to keep up the firing on the Santiago water front. In accordance with this request the batteries at the entrance to the harbor and that of Punta Gorda were heavily bombarded from 5:49 to 7:45 A. M. Rear-Admiral Sampson received a message from Major-General Shafter stating that on July 1 there had been a terrible fight, but that his line was now strongly entrenched about three-quarters of a mile from the town, and urged the Rear-Admiral to make effort immediately to force the entrance to avoid further loss of men in the army, which was already very heavy. Major-General Shafter said: "You can now operate with less loss of life than I can. Please telephone answer," and a message was telephoned to him stating that the batteries had been bombarded and that it was impossible to force the entrance to the harbor until the channel had been cleared of mines, which would be a work of some time after the forts had been taken possession of by the troops. Major-General Shafter made the following reply: "It is impossible for me to say when I can take batteries at entrance to harbor. If they are as difficult to take as those which we have been pitted against, it will be some time and a great loss of life. I am at a loss to see why the Navy cannot work under a destructive fire as well as the Army. My loss yesterday was over 500 men. By all means keep up fire on everything in sight of you until demolished. I expect, however, in time and with sufficient men to capture the forts along the Bay." To this rather sharp message Rear-Admiral Sampson sent Shafter a letter in which he mentioned the fact that the trouble with the Navy "from the first had been with the channel in the harbor which was well strewn with observation mines, which would certainly result in the sinking of one or more ships if they attempted to enter the harbor, and by the sinking of a ship the object of an attempt to enter the harbor would be defeated by the preventing of further progress on our part." Rear-Admiral Sampson said: "If it is your earnest desire that we should force our entrance, I will at once prepare to undertake it. I think, however, that our position and yours would be more difficult if, as is possible, we fail in our attempt. We have in our outfit at Guantanamo forty countermining mines, which I will bring here with as little delay as possible, and if we can succeed in freeing the entrance of the mines by their use I will enter the harbor. This work, which is unfamiliar to us, will require considerable time. It is not so much the loss of men as it is the loss of ships which has until now deterred me from making a direct attack upon the ships within the port." After writing this spirited and eminently common sense letter, Rear-Admiral Sampson began making preparations to countermine with the object of arranging an attack upon the batteries at the entrance. A visit to Major-General Shafter was arranged so that the matter might be thoroughly discussed and combined action take place. Rear-Admiral Sampson started on the "New York" to visit General Shafter at his headquarters.

July 3.—At this time occurred the sortie of Admiral Cervera's squadron and its destruction, which has been the subject of special reports which we have already published in full in our SUPPLEMENT, Nos. 1188, 1189.

This closed the purely naval campaign, crowning with complete success much anxious work. After a careful perusal of the nineteen long galley proofs, in which form we have received the report, the one thought which is uppermost is the wonder that one man could have shouldered such a responsibility as Rear-Admiral Sampson without breaking down under it. His dispatches and orders are models, and show that not a single phase of the subject eluded this astute naval officer, and the wisdom of the naval authorities in making him Commander-in-Chief is also made apparent.

THE GERMINATION OF THE TRUFFLE.

THE mushroom is up to the present the only fungus that it is possible to cultivate on a large scale and to multiply at one's will; and yet it can be propagated only by true cuttings—by a breaking up of the mycelium, the detached fragments of which vegetate, if a proper substratum be furnished them, and produce new receptacles. In reality, this is a roundabout method of reproduction, and the true agent of the spontaneous multiplication, the spore, does not figure in it at all. From a scientific point of view, this process of culture has only a secondary value. The mushroom is transplanted, not sown.



GERMINATION OF THE TRUFFLE.

1. Spores germinating upon the leaves of conifers. 2. Production of the prothallian filament. 3. Pulp of a spore that has not germinated; two years old. 4. Pulp of a spore in course of germination.

It is true that a few other species, such as the Collybia velutipes and the Tricholoma nudum, have given up the secret of the germination of their spores; but the multiplication of these Agaricini remains up to the present rather a laboratory experiment which is not a success unless it is performed by skillful scientists.

The truth is that the artificial propagation of fungi with the spore (the sole rational starting point) as a basis constitutes a problem of which the solution has not yet been found. Several mycologists have made researches in this direction, and some, like MM. Constantin and Matruchot, have obtained substantial results, while M. Gramont de Lesparre has quite recently advanced the question considerably through the discovery of the method of germination of the spores of the truffle.

The truffle is an ascomycete, that is to say, a fungus that produces its spores in small sacks called asci, instead of, as in the Agaricini, upon external projections from the mother cells. These spores are echinulate or are provided with small asperities that give them a rough appearance. Each ascus contains from one to four of them.

There is one remarkable fact that has been recognized for a long time in the history of fungi, and every year adds its quota of discoveries to a more complete knowledge of this peculiarity. The majority, if not all of the species, are polymorphous, that is to say, exhibit several different stages in which all bear spores and are engendered one from the other. Thus, the Agaricini, with a normal fructification represented by basidiospores, offer also reproductive germs in the form of conidia. The Sphæriacei and the Erysiphei present, as their first stage, a mould or a form with pulverulent spores. The Pucciniæ, in germinating, produce teleutospores, which give rise to an Æcidium.

Now, in its first evolution, the truffle presents points of contact with a Puccinia. Like the latter, it is a heterœcious fungus, that is to say, its spores are not capable of germinating unless they fall upon a special

matrix different from that which nourishes the receptacles.

In order that the phenomenon may occur, the spores must be extracted from the asci that contain them, and be deposited naked upon the leaves of certain trees, such as conifers, oaks, hazels, and a few others. The carriage takes place upon the legs or wings of tuber-eating insects, after their mandibles or decomposition have destroyed the walls of the asci that contain the reproductive germs. Owing to the asperities of their surface, the spores easily attach themselves to the limb, and the adhesion to the leaves of conifers is further facilitated by the superficial exudations of the epidermis. The midrib and its vicinity represent the best center of germination.

It is from the middle of November to the month of January that the phenomena of germination exhibit themselves most fully. They may be observed not only upon fresh and humid leaves, but also upon such as are already old and dry. The spores are of two kinds, the protoplasm of one being complementary to that of the other. In both cases, the product of germination is a filamentous prothallus.

From January to June the germination is retarded, and occurs only exceptionally; but beginning with July the phenomena are resumed with activity and follow the same order as in winter, with the difference that the prothallian filaments, instead of developing superficially, make their way under the epidermis and consequently remain invisible. They are then revealed externally only when their terminal pseudospores make their way to the light through the tissue of the nourishing leaf.

After fecundation, the female prothallus (spore or pseudospore) emits slender and transparent subepidermic filaments, which make their way through the parenchyma. Their passage is revealed only through the black, hard, shining spores that they send to the surface. These constitute the teleutospores and form the starting point of the truffle mycelium. In summer they make their appearance in from four to six weeks after being sown. Beginning with the middle of October, they emit a few germinative filaments.

If, during the summer season, the leaves are gathered before the appearance of the teleutospores or the first manifestations of their activity, the latter do not form, and, in many cases, it is impossible to obtain any of them from leaves detached in September and preserved until November. If the leaves are gathered too soon, some of the pseudospores already well formed may become etiolated. From this it must be concluded (especially if it be considered that germination takes place perfectly upon dry leaves) that the yellow tissues, full of sap, are not a very favorable matrix for the production of the teleutospores, and that the materials necessary for their prompt evolution accumulate only with the retardation of the vegetation and the desiccation of the leaves.

In winter the period between the sowing and the germination is very much abridged, and may be reduced to two weeks. In neither case do the teleutospores reach maturity unless they have attained the age of six weeks from the time of sowing. According as the leaf does or does not contain water, the production of filaments by the teleutospores may take place previous to complete maturity, or else manifest itself in no manner, although the teleutospore be completely ripe and ready to detach itself.

The aptness of the spores to germinate depends upon their state of preservation. The tissue of the mature truffle that remains in the ground either becomes dry and hard or else enters into fermentation through the action of a saccharomyces, and disengages ammonia. In the first case, the asci remain intact, and the spores that they inclose are for the most part apt to germinate. On the contrary, if putrefaction or fermentation attacks the truffle before its desiccation, the spores will be destroyed or no longer be able to germinate.

As the truffle is very fermentable by reason of the quantity of nitrogen (1·5 per cent.) and water (72 per cent.) that it contains, the species would run a great risk of quickly disappearing, since the few spores adapted for germination and that escape putrefaction are able to develop only from November to January, while the maturity itself is posterior to such date. But the object of the aroma of the truffle is precisely to prevent putrefaction by acting as an antiseptic. It is sufficiently powerful to preserve from decomposition a specimen inclosed for several months, with a little water, in a hermetically corked bottle. Under the same conditions, if the odor were allowed to evaporate, the truffle would become rotten in a fortnight.

In addition to this antiseptic role, the aroma performs further the incidental function of revealing the place where the truffle is found to the sense of small insects, which feed upon the fungus and carry the asci to the leaves upon which the spores are to germinate.

The nature and exposure of the leaves are important factors to be considered in the germination of the spores of the truffle. From May to the end of June the hazel gives better results than the oak, since later on the evolution is more rapid upon the leaves of this plant. Generally speaking, the germination is more difficult upon the leaves of conifers, and at the end of autumn the thickening of the sclerenchyma offers an almost insurmountable obstacle to the subepidermic progress of the filaments. From July to October all the leaves give better results when they are protected from strong draughts of wind and pelting rain and are well sheltered from the sun.

Some practical applications of M. de Lesparre's discoveries have been tried, but a certain length of time is required in order to allow results to be obtained. If success crowns such efforts, we shall be in possession of a rational and scientific method of cultivating a fungus which is highly appreciated by gourmets; and perhaps analogy will lead to similar results, theoretical and practical, with other species that are equally interesting, such, for example, as the morel, which is so near a relative of the truffle.—Cosmos.

Spotting Cigar Wrappers.—The essentials are that the liquor must be freshly prepared. It soon loses strength on standing. Labarraque's solution or Javelle water will, either one of them, produce the effect required. Another "bleach" or "spotter" is as follows: Dissolve 1 part of calcium chloride in 16 parts of distilled water. Add sufficient acetic acid to set free chlorine, and use at once.

ANTHROPOLOGY.*

I AM very sensible of the honor of presiding over this section at a Bristol meeting. Bristol, from its association with the memory of J. C. Prichard, may be regarded as the very birthplace of British anthropology.

In submitting to this section some observations on the past progress and the present position of the anthropological sciences I use the plural term, which is generally adopted by our French colleagues, in order to remind you that anthropology is in fact a group of sciences. There is what in France is called pure anthropology or anthropology proper, but which we prefer to call physical anthropology—the science of the physical characters of man, including anthropometry and craniology, and mainly based upon anatomy and physiology. There is comparative anthropology, which deals with the zoological position of mankind. There is prehistoric archæology, which covers a wide range of inquiry into man's early works, and has to seek the aid of the geologist and the metallurgist. There is psychology, which comprehends the whole operations of his mental faculties. There is linguistics, which traces the history of human language. There is folklore, which investigates man's traditions, customs, and beliefs. There are ethnography, which describes the races of mankind, and ethnology, which differentiates between them, both closely connected with geographical science. There is sociology, which applies the learning accumulated in all the other branches of anthropology to man's relation to his fellows, and requires the co-operation of the statistician and the economist. How can any single person master in its entirety a group of sciences which covers so wide a field, and requires in its students such various faculties and qualifications? Here, if anywhere, we must be content to divide our labors. The grandeur and comprehensiveness of the subject are among its attractions. The old saying, "I am a man, and therefore I think nothing human to be foreign to me," expresses the ground upon which the anthropological sciences claim from us a special attention.

I may illustrate what I have said as to the varied endowments of anthropologists by a reference to the names of four distinguished men who have occupied in previous years the place which it falls to my lot to fill to-day—most unworthily, as I cannot but acknowledge, when I think of their pre-eminent qualifications. When the Association last met at Bristol, in 1875, anthropology was not a section, but only a department, and it was presided over by Rolleston. There may be some here who recollect the address he then delivered, informed from beginning to end with that happy and playful wit which was characteristic of him; but all will know how great he was in anatomy, what a wide range of classical and other learning he possessed, and how he delighted to bring it to bear on every anthropological subject that was presented to his notice. In 1878 Huxley was the chairman of this department. It is only necessary to mention the name of that illustrious biologist to recall to your memory how much anthropology owes to him. Eight years before, he had been president of the Association itself, and seven years before that had published his "Evidence as to Man's Place in Nature." Brilliant as his successes were in other branches of scientific investigation, I cannot but think that anthropology was with him a favorite pursuit. His writings upon that subject possess a wonderful charm of style.

In 1883 the chairman was Pengelly, who for many years rendered service to anthropology by his exploration of Kent's Cavern and other caves, and who happily illustrated the close relation that exists between geology and anthropology. His biography, recently published, must have reminded many of us of the amiable qualities which adorned his character. Finally, in 1886, two years after anthropology had become a section, its president was Sir George Campbell, a practical ethnologist, a traveler, an administrator, a legislator, a geographer, who passed through a long career of public life with honor and distinction. All my other predecessors are, I am glad to say, still living, and I make no mention of them. The few names I have cited—selected by the accidental circumstance that they are no longer with us—are sufficient to show what varied gifts and pursuits are combined in the study of anthropology.

There is another side to the question. Great as is the diversity of the anthropological sciences, their unity is still more remarkable. The student of man must study the whole man. No true knowledge of any human group, any more than of a human individual, is obtained by observation of physical characters alone. Modes of thought, language, arts, and history must also be investigated. This simultaneous investigation involves in each case the same logical methods and processes. It will in general be attended with the same results. If it be true that the order of the universe is expressed in continuity and not in cataclysm, we shall find the same slow but sure progress evident in each branch of the inquiry. We shall find that nothing is lost, that no race is absolutely destroyed, that everything that has been still exists in a modified form, and contributes some of its elements to that which is. We shall find that this, which no one doubts in regard to physical matters, is equally true of modes of thought. We may trace these to their germs in the small brain of the palæolithic flint worker; or, if we care to do so, still farther back. This principle has, I understand, been fully accepted in geology and biology, and throughout the domain of physical science—what should hinder its application to anthropology? It supplies a formula of universal validity, and cannot but add force and sublimity to our imagination of the wisdom of the Creator. It is little more than has been expressed in the familiar words of Tennyson:

> "Yet I doubt not thro' the ages one increasing purpose runs,
> And the thoughts of men are widen'd with the process of the suns;"

and supports his claim to be "the heir of all the ages, in the foremost files of time."

I propose, in briefly drawing your attention to some recent contributions to our knowledge, to use this as a convenient theory and as pointing out the directions in which further investigation may be rewarded by even fuller light.

Applying it, first of all, to the department of physical anthropology, we are called upon to consider the discovery by Dr. Dubois, at Trinil, in Java, of the remains of an animal called by him Pithecanthropus erectus, and considered by some authorities to be one of the missing links in the chain of animal existence which terminates in man. In his presidential address to this Association last year, Sir John Evans said: "Even the Pithecanthropus erectus of Dr. Eugène Dubois from Java meets with some incredulous objectors from both the physiological and the geological sides. From the point of view of the latter the difficulty lies in determining the exact age of what are apparently alluvial beds in the bottom of a river valley." In regard to these objections, it should be remembered that though the skull and femur in question are the only remains resembling humanity discovered in the site, it yielded a vast number of fossil bones of other animals, and that any difficulty in settling the geological age must apply to the whole results of the exploration.

The physiological difficulties arise in two points—do the skull and femur belong to the same individual? Are they or either of them human, or simian, or intermediate? As to the first, it is true that the two bones were separated by a distance of about fifty feet, but as they were found precisely on the same level, accompanied by no other bones resembling human bones, but by a great number of animal remains, apparently deposited at the same moment, the theory that they belonged to different individuals would only add to the difficulty of the problem. With regard to the skull, a projection of its outline on a diagram comparing it with others of low type belonging to the stone age shows it to be essentially inferior to any of them. With regard to the thigh, you will recollect that at the Liverpool meeting of this section, Dr. Hepburn displayed a remarkable collection of femora from the anatomical museum of Edinburgh University, exhibiting pathological and other conditions similar to those in the femur of Trinil. Though this evidence tends to show that the bone is human, it is not inconsistent with, but, on the contrary, goes to support the conclusion that it belongs to an exceedingly low and ancient type of humanity. Whether, therefore, we call the remains Pithecanthropus erectus with their discoverer, or Homo pithecanthropus with Dr. Manouvrier, or Homo Javanensis primigenius with Dr. Houzé, we are in presence of a valuable document in the early evolution of mankind.

One element of special interest in this discovery is that it brings us nearer than we have ever been brought before to the time when man or his predecessor acquired the erect position. I believe that it is acknowledged by all that the femur belonged to an individual who stood upright, and I presume that the capacity of the skull, being greater than that of any known anthropoid, is consistent with the same inference. The significance of that has been most clearly set forth by my predecessor, Dr. Munro, in his address to this section at Nottingham in 1893. He showed that a direct consequence of the upright position was a complete division of labor as regards the functions of the limbs—the hands being reserved for manipulation and the feet for locomotion; that this necessitated great changes in the general structure of the body, including the pelvis and the spinal column; that the hand became the most complete and effective mechanical organ nature has produced; and that this perfect piece of mechanism, at the extremity of a freely moving arm, gives man a superiority in attack and defense over other animals. Further, he showed that, from the first moment that man recognized the advantage of using a club or a stone in attack or defense, the direct incentive to a higher brain development came into existence. The man who first used a spear tipped with a sharp flint became possessed of an irresistible power. In his expeditions for hunting, fishing, gathering fruit, etc., primitive man's acquaintance with the mechanical powers of nature would be gradually extended; and thus from this vantage point of the possession of a hand, language, thought, reasoning, abstract ideas, would gradually be acquired, and the functions of the hand and the brain be developed in a corresponding manner. I do injustice to Dr. Munro's masterly argument by stating it thus crudely and briefly. It amounts to this—once the erect position is obtained, the actions of man being controlled by a progressive brain, everything follows in due course.

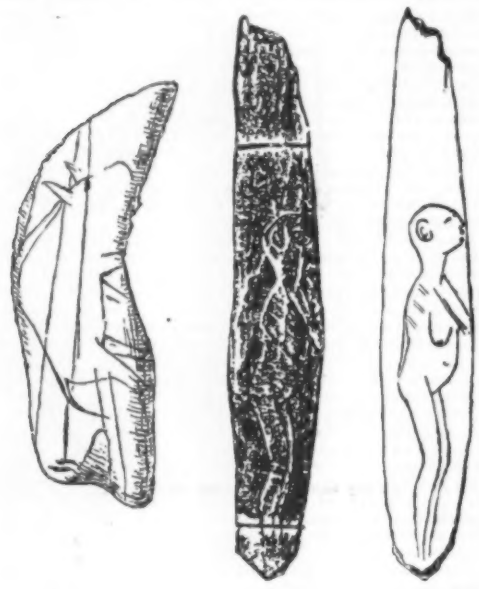
The next stage which we are yet able to mark with certainty is the paleolithic, but there must have been a great many intermediate stages. Before man began to make any implements at all, there must have been a stage of more or less length, during which he used any stick or stone that came to his hands without attempting to fashion the one or the other. Before he acquired the art of fashioning so elaborate an implement as the ordinary paleolithic ax or hammer, there must have been other stages in which he would have been content with such an improvement on the natural block of flint as a single fracture would produce, and would proceed to two or three or more fractures by degrees. It must have been long before he could have acquired the eye for symmetry and the sense of design, of adaptation of means to ends, which are expressed in the fashioning of a complete paleolithic implement. It is probable that such rude implements as he would construct in this interval would be in general hardly distinguishable from flints naturally fractured. Hence the uncertainty that attaches to such discoveries of the kind as have hitherto been made public. Prof. McKenny Hughes, who speaks with very high authority, concludes a masterly paper in The Archæological Journal with the statement that he has "never yet seen any evidence which would justify the inference that any implements older than paleolithic have yet been found." The name "paleotalith" which had been suggested for prepaleolithic implements seems to him unnecessary at present, as there is nothing to which it can be applied; and as it will be long before it can be asserted that we have discovered the very earliest traces of man, he thinks it will probably be long before the word is wanted. An elaborate work on the ruder forms of implement, just published by M. A. Thieullen, of Paris, who has for many years been engaged in collecting these objects, adds materially to our knowledge of the subject.

Another line of argument bearing strongly in the same direction is afforded by the discovery in various places of works of art fabricated by early man. The

* Opening address by E. W. Brabrook, C.B., F.S.A., president of the section, at the meeting of the British Association.

statuettes from Brassempouy, the sculptures representing animals from the Bruniquel, the well known figure of the mammoth engraved on a piece of ivory from Périgord, and many other specimens of early art attest a facility that it is not possible to associate with the dawn of human intelligence. M. Salomon Reinach tells an amusing story. A statuette in steatite of a woman, resembling in some respects those of Brassempouy, was discovered in one of the caverns of Mentone, as far back as 1884, but when the discoverer showed it to a personage in the locality, that authority advised him not to let it be seen, lest it should take away from the belief in the antiquity of the caves, it being then thought too artistic to be consistent with early man. The finder acted on this advice, in ignorance of the real interest of the statuette, until April, 1896, when he showed it to M. Reinach and M. Villenoisy, who promptly interviewed the sage adviser in question, and obtained a confirmation of the statement. Some interesting additions to our gallery of prehistoric art have been recently made by M. Emile Rivière and M. Berthoumeyrou, at Cro-Magnon in the Dordogne. These are a drawing of a bison and another of a human female in profile, which M. Rivière has kindly allowed me to reproduce. Among the other objects found in the same place were some flint implements brought to a fine point, suitable for engraving on bone or horn.

The idea of making in any form a graphic representation of anything seen has never, so far as I know, occurred to any lower animal; and it could hardly have been among the first ideas formed in the gradually developing human brain. When that idea is found carried out with remarkable artistic skill, by means of implements well adapted for the purpose, we may



surely assume that the result was not obtained till after a long interval of time, and was approached by gradual steps marked by progress in other faculties, as well as in the artistic faculty. It may be that some day all uncertainty on this head will be removed by decisive discoveries.

The interval between the Paleolithic and Neolithic periods rests in the like condition of incertitude. That by some means, and somewhere on the face of the globe, the one period gradually passed into the other we cannot but believe. That the transition between them may have involved innumerable degrees is also highly probable. Where and when and how each step was taken we do not know at present, and possibly never shall know. The problem is not satisfactorily solved by the production of paleolithic implements resembling neolithic forms or neolithic implements resembling paleolithic forms; inasmuch as between the one period and the other an interval of time involving geological and other changes has to be accounted for.

In this respect, also, our best authorities are the most cautious and conservative. In the excellent address which Prof. Boyd Dawkins delivered to the Royal Archæological Institute at the Dorchester meeting last year, on the present phase of prehistoric archæology, he contrasted the few primitive arts, such as sewing and the manufacture of personal ornaments and rude implements of the chase, possessed by the paleolithic hunters—apart from their great proficiency in the delineation of animals—with the variety of arts, such as husbandry, gardening, spinning, weaving, carpentry, boat building, mining, and pottery making, possessed by the neolithic herdsmen, and held that between the two there is a great gulf fixed. Somewhere that gulf must be bridged over. Prof. Boyd Dawkins says that the bridge is not to be found in the caverns of the south of France. It is difficult to meet his argument that the presence of grains of barley and stones of the cultivated plum at Mas d'Azil are evidences of neolithic civilization. His objections to other discoveries are not so strong as this, but are strong enough to make us pause. The tall, long-headed people, whose remains were found at Cro-Magnon, he holds to be early neolithic and not paleolithic, to s and on the near side and not on the far side of the great gulf.

These considerations lend importance to the discoveries which have been laid before this Association at previous meetings by Mr. Seton-Kerr, and which have also been commented upon by Prof. Flinders Petrie and Sir John Evans. If we are compelled to admit a breech of continuity in Europe, is it in Africa that we shall find the missing links? That is another of the great problems yet unsolved. The evidence we want relates to events which took place at so great a distance of time that we may well wait patiently for it, assured that somewhere or other these missing links in the chain of continuity must have existed and probably are still to be found.

The next stage, which comprises the interval between the neolithic and the historic periods, was so ably dealt with by Mr. Arthur J. Evans in his address to this section at the Liverpool meeting that it does not call for any observations from me. Two committees appointed by the Association in connection with this section touch upon this interval—the committee for investigating the lake dwellings at Glastonbury and the committee for co-operating with the explorers of Silchester in their well-conducted and fruitful investigation of the influence of Roman civilization on a poor provincial population. I pass on to consider the very great progress that has been made of late years in some of the branches of anthropology other than physical and prehistoric, and especially in that of folk-lore. I do this the more readily because I do not recollect that folk-lore has ever before been prominently referred to in an address to this section. It is beginning to assert itself here, and will in time acquire the conspicuous position to which it is becoming entitled, for the British Association is sensitive to every scientific movement, and responds readily to the demands of a novel investigation. Already, for three or four years, a day has been given at our meetings to folk-lore papers; and at the Liverpool meeting an exceedingly philosophic, and at the same time practical, paper was read by Mr. Gomme, and is printed in extenso in the Proceedings as an appendix to the Report of the Ethnographic Survey Committee. The term "folk-lore" itself is not without a certain charm. It is refreshing to find a science described by two English syllables instead of by some compound Greek word. The late Mr. W. J. Thoms had a happy inspiration when he invented the name. It is just twenty years since the Folk-Lore Society was established under his direction. It has accumulated a vast amount of material and published a considerable literature; it is now rightly passing from the stage of collection to that of systematization, and the works of Mr. J. G. Frazer, Mr. E. Sidney Hartland, and others, are pointing the way toward researches of the most absorbing interest and the greatest practical importance.

A generalization for which we are fast accumulating material in folk-lore is that of the tendency of mankind to develop the like fancies and ideas at the like stage of intellectual infancy. This is akin to the generalization that the stages of the life of an individual man present a marked analogy to the corresponding stages in the history of mankind at large; and to the generalization that existing savage races present in their intellectual development a marked analogy to the condition of the earlier races of mankind. The fancies and ideas of the child resemble closely the fancies and ideas of the savage, and the fancies and ideas of primitive man.

(To be continued.)

THE DIGNITY OF ANALYTICAL WORK.*

It will doubtless be conceded by all that in the choice of the field to which one proposes to devote his life-work a number of things should be consulted. Among these may be mentioned not only mental capacity and the opportunities for training by courses of study which may be available to him, but also what may be termed natural inclination or love for the work. Just how much work should be given to each of these elements is a query not easily answered, but few will deny that genuine interest in or real love for the field of work chosen should be allowed as great sway as possible. Those of us who have got far enough along in our life-work to be able to look back somewhat, and to see and to differentiate the causes that have shaped our line of effort, know full well that circumstances beyond our control, rather than our inclinations and desires, have in many cases determined our course; but the fact nevertheless remains that, for the best results, for the attainment of even moderate success, one's efforts must be in an agreeable field and his heart must be in his work. Fortunate is the man for whom circumstances so shape themselves that he is able to pass his years in the field of his choice and spend and be spent in work that is congenial to him.

Assuming now that, for most of us, circumstances and conditions have been such that we are spending our lives in the field of our choice, let us consider, for a moment, a tendency that seems to be a concomitant of those thus fortunately situated. Do we not occasionally find in ourselves a disposition to magnify the importance of the field in which we happen to be engaged? Are we not somewhat inclined, quite naturally perhaps, to think that our field of work is more important than that in which others are occupied? Does not the theoretical chemist, whose inclinations lead him to spend his time in writing reactions and building structural formulæ of wondrous architecture, often feel within himself that his work is on a higher and nobler plane than that of the patient analyst who has furnished the data which he uses? Does not the organic chemist who delights in the study of the carbon compounds, who can repeat for you series after series of chemical bodies, differing from one another by the constant addition of an element, or group of elements, in whose vocabulary "types," "substitution," "replacements," "condensations" and "isomers" are familiar words, and who when a new organic compound is discovered cannot rest until he has found to what series and what place in the series it belongs, or what its relations are to other bodies in that marvelous structure, based on the element carbon, which the studies of the last half century have reared before our eyes—I say does not this organic chemist oftentimes feel that he is engaged in a field far more worthy of study, to which is due much more consideration, than to that of his inorganic brother who devotes days, and perhaps weeks, to unraveling the constitution of some obstinate silicate whose crystalline form gives little help, and whose oxygen ratio is hidden or obscure? Or, again, does not the physical chemist oftentimes think that with the tools of his more especial field, with his specific heats, his vapor densities, his heat of chemical combination and his ions, he is quite competent to solve all problems worth solving in the realm of chemistry, and that those who are engaged in other lines are far below his standard, and can be looked down upon with quite pitying sympathy? Still once more, do we not often see the pure chemist, whose battle cry is "original work for the work's own sake," claim for himself the highest seat in the synagogue, and refuse to join his efforts with those of others whom he regards as his humbler brethren, viz., those working in the field of applied chemistry, in securing the benefits of organization to extend and widen the borders of our science? Finally, not to make distinctions, do we not frequently see the analyst, who knows so well how necessary it is to have the trained and skillful hand and the acute and watchful brain both working together and at the same time, in order to secure the accuracy without which his work is worthless, claiming for his field that it is the foundation upon which our science rests, and that those who spend their time in locating the position of an atom in its molecule, or in finding the relations of an organic compound to other members of its series, or perchance in inventing long names for new compounds in which all the resources of the ancient Greek and Latin are brought to bear, to reveal in one word the constitution of the compound—I say does not the analytical chemist often regard these workers as unworthy to be called chemists?

Now, far be it from me to say that this partiality of each for his own field is blameworthy. We can, indeed, conceive of cases in which this partiality may be carried a little too far, but within proper limits not only is it not blameworthy, but even, as it seems to us, it may be praiseworthy for one to magnify the importance of the work in which he is engaged. A just and proper estimate of the value of his own work, a reasonable pride in his chosen science, or in that paddock of his science which it has fallen to the share of each to care for and cultivate, and indeed a moderate, though necessarily a somewhat partial, comparison of himself and his field of labor with others, even though that comparison is somewhat to the detriment of the others, are not always necessarily bad. On the other hand, such pride and such comparisons tend to stimulate to renewed activity, tend to sustain in the perplexities and discouragements of work, and tend to keep one's effort concentrated on the work which he can do best. Looked at in this light, the generous rivalry of one branch of our science with another, or the pardonable pride of each in his own chosen field, and even in his own work, may be a distinct advantage, and I know you will bear with me a few minutes, while I, with proper modesty and in the true spirit, I hope, try to magnify a little the field of analytical work.

To my mind, then, it is just and proper to take pride in analytical chemistry, because of the power which a properly conceived and executed analysis has of explaining difficulties. A few illustrations will, perhaps, make this point clear, and I am sure I shall be pardoned for giving illustrations from my own experience, rather than historical ones.

Some years ago, after a passenger coach on the Pennsylvania Railroad had been through the hands of the car cleaners, it was noticed by some of the officers that the paint on the outside looked very badly, and had apparently been injured by the cleaning. A careful examination by the paint experts revealed the fact that the varnish was nearly all gone, and in some places the paint itself partially removed. As a matter of discipline, the car cleaners were called to account, and requested to explain why the paint and varnish had been so badly injured. Their reply was that with the soap that was furnished for car cleaning no better results could be obtained. This statement was, of course, received with a grain of allowance, it being well known to railroad operating officers that almost universally, when anything goes wrong, and the men are called to an account, the materials are blamed. However, in order to give the men the benefit of the doubt, a sample of the soap was obtained and submitted to analysis, when it was found that this soap actually contained over three per cent. of free caustic soda and about seven per cent. of sodium carbonate. It is evident that this soap had been very carelessly made from cheap materials, and, since it is well known that water solutions of both caustic and carbonated alkalies are fairly good solvents for dried linseed oil and other constituents of paint and varnish, it is clear that the defense of the men, in this case at least, was legitimate and that the soap was really at fault. It may be added, for information, that the circumstances above described led to the preparation of a specification for common soap, in which the amount of free and carbonated alkali was limited to very low figures, and that no similar difficulty of destruction of paint and varnish has since occurred.

Another illustration from a different field will emphasize the power of an analysis to explain difficulties. A lot of boiler-plate was at one time received at the Altoona shops from one of the best makers. In this lot of forty or fifty sheets two were found which gave difficulty in flanging, this operation consisting, as is well known, in bending over the edges of the sheets while hot, nearly at right angles to the balance of the sheet, in order to enable it to be joined to other sheets in the boiler. The two sheets referred to cracked in the bend, although the remainder of the lot gave no difficulty from this cause. The workmen being thoroughly experienced, and the practices of the shop being excellent, the cause of the failure in the case of these two sheets was not apparent. An analysis of samples from each of these sheets, however, showed 0·35 per cent. and 0·36 per cent. of carbon respectively, while analyses of samples from other sheets in the same lot showed in no case above 0·12 to 0·15 per cent. of carbon. The explanation of the difficulty seemed now quite clear. The shops had been supplied for a long time with the softer grade of steel, and the methods and practices in use were those applicable to that kind of steel. No wonder, then, that with the harder grade difficulty should arise, as actually happened, and but for the analysis this might have passed into shop traditions as one of those unexplained and unexplainable crotchets of steel which both the makers and practical users of this metal delight in constantly bringing forward.

A single illustration further will, perhaps, suffice on this head. A few years ago a shipment of some three hundred freight axles was received at two different shops on the Pennsylvania Railroad, from an entirely

* Presidential address, by Mr. C. B. Dudley, delivered at the Washington meeting of the American Chemical Society, December 29, 1897.—From Science.

reputable maker. Some of these axles were used for repairs and some went under new cars. Scarcely had they got into service, however, before difficulty began to arise. The axles began to break. Indeed, one of them broke before the car had been turned out of the shop yard, one broke into three pieces before the car had made 150 miles, and in less than three months eight had broken. Each of the broken axles was sent to the laboratory, and a careful study of the case made, with the hope of discovering the cause of the failure. An examination of the freshly fractured ends of several of the broken axles showed that for a little distance in from the circumference the fractured steel presented an appearance quite different from that given by the remainder of the fracture. Moreover, a line of demarkation between these two apparently different kinds of steel in the same axle could be clearly traced. Accordingly, it was decided to make analysis of borings from near the circumference and near the center, and see whether this would reveal anything. It may be stated that the axles were known to have been made from Bessemer steel, and should normally have contained not more than 0·10 per cent. of phosphorus. The analysis of the borings from near the circumference of the axles in no case gave figures up to this limit, while the borings from the center of the axles in no case showed less than 0·16 per cent. phosphorus, and in some cases the amount was as high as 0·24 per cent. Those who are familiar with the methods in daily use in modern steel works will, from these figures, at once understand the cause of breakage of these axles. For the benefit of those who are not, it may be well to explain that in most modern steel works large ingots are now the rule, and that in large ingots, which take considerable time to solidify from the molten condition, analyses show that some of the constituents of the steel are not uniformly disseminated throughout the mass. This separation of the constituents during cooling, technically known as "segregation," is characteristic of the carbon, the phosphorus, and the sulphur. Furthermore, the segregation appears to be worst in the upper third of the ingot, so much so that many specifications now require the upper third of the ingot to be removed, and not used at all in making the articles the specifications called for. This much being stated, it is clear why our axles broke. They were made from badly segregated steel, perhaps from the rejected upper thirds of a lot of ingots, the balance of which were used for other purposes. Subsequent correspondence with the parties furnishing the axles gave good grounds that such was the case. For the comfort of those who ride on railroads, it may be added that the 300 axles were at once withdrawn from service, and that since that time a chemical and physical specification for both passenger and freight axles has been prepared which is believed to preclude the possibility of such axles as are described above being received by the Pennsylvania Railroad.

These illustrations of the power of an analysis to explain difficulties could be prolonged to almost any extent, but I spare you. Furthermore, I should not like to be understood as claiming that every puzzle, every difficulty or every state of affairs in nature where the reasons for the phenomena which we find are not apparent at sight can be explained by a chemical analysis. Our knowledge is far too limited for this. Moreover, many cases could be cited in which an analysis throws no light whatever on the situation; but, notwithstanding this, an experience of some twenty years in seeking out the causes of things, as a necessary preliminary to the intelligent modification of practices and methods in connection with a great corporation, has continually impressed me more and more with the very great help which a properly conceived and executed analysis can give in cases of difficulty.

But, again, I take pride in the field of analytical work, because of the opportunity which thoughtful analytical work affords for finding new things. The careful, thoughtful, observant analyst is constantly on the verge of either being able to add to his own knowledge or of being able to contribute something to the general progress of our science. And here, again, I must be pardoned for using as illustrations cases which have arisen in the laboratory of the Pennsylvania Railroad Company.

A few years ago, in our laboratory, we began to get ready to make our analyses of the samples of steel which were designed ultimately to be the international standards for the analysis of iron and steel. Before starting in on these samples, however, it was deemed prudent to do a little preliminary work on some other samples, with the idea in mind of seeing whether apparatus and method were satisfactory. Accordingly, four separate and distinct determinations on the same sample were made for carbon, using the double chloride of copper and ammonium to release the carbon, and burning in oxygen gas. The four determinations agreed with each other within 0·01 or 0·02 of a per cent., and were regarded as fairly satisfactory. But as the work was important, and as some parts of the apparatus had not worked quite satisfactorily, it was decided to repeat the four determinations. Meanwhile a new stock bottle of solution of the double chloride had been made exactly in the manner that had been our custom for some time previous. When the second four determinations were obtained they differed from the first by more than a tenth of a per cent. I need not weary you with the details of our hunt for the cause of this discrepancy, how every point in the apparatus was tested one after another, how various modifications were tried, how combustions were made on crystallized sugar to check ourselves, and how finally we located the difficulty in the double chloride of copper and ammonium solution. These details all have been published.* Suffice it to say that, as the result of this work, together with subsequent work by other chemists, it is, we believe, now generally accepted that the commercial ammonium double salt contains carbon in some form, probably pyridine, that its use as a solvent to release the carbon from iron and steel is unreliable, and that the substitution of the potassium for the ammonium double salt overcomes these difficulties. The point which I especially want to emphasize is that, in trying to do a little careful analytical work, we struck a new and apparently hitherto unsuspected source of error in one of the oldest and best established methods of iron and steel analysis.

Another illustration will, perhaps, make this point still more clear. In the regular course of work, at one time a silicon determination was made in a piece of tire steel which had been sent by an officer of another railroad for information. The figures found by our analysis were 0·14 per cent., these figures being sent to the officer above referred to. A little later word was received that an analysis of a sample from the same tire by another chemist gave 0·28 per cent. as the content of silicon. This, of course, led us to look over our work, with the idea of finding where the cause of the discrepancy lay. A careful examination of our weights and figures showed that it was not an error of calculation. Accordingly, we decided to duplicate our work, need I say, with the expectation of finding that the other chemist had made a mistake? Judge of our surprise when we found that our second analysis confirmed his figures exactly. Our first and second analyses had been made by the same method, and by the same operator, working on borings from the same bottle, and the cause of the discrepancy between the two was not, therefore, at first sight apparent. On carefully questioning the operator, however, as to exactly what he did at each step of the method, a clew was obtained, which, when followed out, cleared up the whole difficulty and ultimately led to a modification of the method. The silicon in these samples was determined by what is known as Drown's method, which consists in dissolving the steel in nitric acid, adding sulphuric, heating until white fumes of the latter acid appear, to render the silica insoluble, dilution with water, filtration, washing, and weighing. The difference between our two analyses consisted simply in this, that in the first case, after the dilution with water, there being considerable work in hand, the vessel was allowed to stand overnight before filtration, while in the second case filtration immediately followed dilution. Subsequent work on this point showed that in this method silica is not completely dehydrated by heating in concentrated sulphuric acid in presence of iron salts, but is apparently rendered colloidal and sufficiently dehydrated, so that, if filtration follows soon after dilution, fairly accurate results will be obtained. On standing after dilution, however, this colloidal, undehydrated silica, apparently goes into solution again. Indeed, we were able to get on this same sample, anywhere from one-eighth up to the full amount of silicon present, by varying the time of standing after dilution, the longest time covered by our experiments being about four days.

Perhaps I may venture to give you still one more illustration of how, in the course of analytical work, new and apparently hitherto unnoticed reactions may be hit upon and modifications of methods result. Every chemist who has done much work in determining phosphorus in iron or steel, by the reduction of the molybdic acid of the yellow ammonium phosphomolybdate and subsequent titration of the reduced solution, cannot fail to have been annoyed by the occasional failure of duplicates to agree. Apparently, in the two analyses everything has been done exactly alike, and yet the results do not agree. Every thoughtful chemist cannot fail to have felt at such times that somewhere in the method there were conditions affecting the result that were not fully controlled. During the last six or eight months in our laboratory we have apparently struck one of these hitherto uncontrolled conditions, whose influence is not large, and yet enough at times to cause annoying discrepancies in duplicates, or between different chemists working on the same sample.

In order to make clear what follows, it should be stated that in the ordinary working of this method the yellow precipitate, after careful washing, is dissolved in ammonia, and this solution is then treated with sulphuric acid largely in excess and diluted to a definite volume, in which condition it is passed through the reductor and subsequently titrated with standard potassium manganate. The reductor in common use consists, as is well known, of a tube of heavy glass, about five-eighths of an inch internal diameter and about a foot long, filled with powdered zinc, the top being fitted with a funnel and the bottom with a stopcock. Below the stopcock a smaller tube carries the rubber cork by means of which the reductor is fitted to the flask which receives the reduced solution. This smaller tube usually projects into the flask an inch or two, and it is customary to use the pump to draw the liquid through the reductor. This much being premised, we may say that in a communication from Mr. Porter W. Shimer, one of the members of the Sub-Committee on Methods of the Committee on International Standards for the Analysis of Iron and Steel, he, among other things, called attention to the fact that, when making a number of determinations on the same sample, all other things being the same, he got a reduced solution that required more permanganate if he prolonged the small tube below the stopcock in the reductor nearly to the bottom of the flask than if this small tube projected only an inch or two into the flask. This statement brought afresh to our minds a thought that every one who has worked much with molybdic acid must have had: viz., that reduced molybdic acid is very easily reoxidized. We accordingly determined to find out, if possible, whether this was actually the case, and, if so, how much this difficulty might amount to. Accordingly, a stock solution of ammonia molybdate dissolved in water was prepared, and a number of aliquot parts of this solution measured out. Now, obviously, there are two chances for the reduced solution to become oxidized by exposure to the air. One of these is from the air in the flask during the reduction and the other from the outside air during the titration. Without going into minute detail, it is, perhaps, sufficient to say that when we reduced an aliquot part of our stock solution, using the short tube of the reductor and adding the permanganate drop by drop, with continual agitation during the whole titration, we used 22·7 c. c. of our standard permanganate, all figures given being a mean of a number of closely agreeing determinations. When now we made the reduction the same as before, viz., with the short tube of the reductor, but titrated by allowing about 95 per cent. of the permanganate required to run into the flask before agitation at all and finishing the titration drop by drop, we used 23·1 c. c. of permanganate; in other words, so sensitive is a reduced solution of molybdic acid that it is easy, by varying the mode of titration, to introduce considerable error. Prolonging now the tube at the bottom of the reductor as suggested by Shimer, which would result, as is apparent, in a diminished exposure of the reduced solution to the air in the flask before titration, we found our aliquot part to use up 23·6 c. c. of permanganate. But even with the prolonged tube there is some exposure of the reduced solution to the air during the reduction. Accordingly, on the suggestion of my principal assistant, Mr. F. N. Pease, we put a measured amount of standard permanganate solution into the flask which was to receive the reduced solution, more than sufficient to react with it, and then prolonged the tube from the reductor, to dip below the surface of this permanganate. Obviously, with this arrangement the reduced solution is entirely prevented from air exposure. On making the reduction and titrating the excess of permanganate with standard solution of ferrous sulphate, it was found that the aliquot part had now used up 24·1 c. c. of permanganate, an extreme difference in amount of permanganate used under the varying conditions described of nearly 6 per cent. Obviously, if two chemists were working on the same sample of molybdic acid, one employing the manipulation first described and the other that last described, the discrepancy between them would be serious. The discrepancy on phosphorus in steel, while the same in percentage, is very much smaller in actual figures, but still enough to be annoying. The work above referred to is not yet quite finished, but enough has already been done to demonstrate that the ordinary method of determining phosphorus in steel can be advantageously modified in the interests of greater accuracy; and also, although not yet rigorously demonstrated, there are strong indications that molybdic acid (MoO_3) is always reduced by zinc to Mo_2O_3, and that the more complex formulas, $Mo_{12}O_{19}$, $Mo_{24}O_{37}$, etc., so commonly given as representing this reduction, simply mean that the conditions under which these formulæ were obtained permitted the reoxidation of the reduced solution to the extent indicated.

There is another phase of this question we are discussing, "The Dignity of Analytical Work," which will, perhaps, bear a few words. It seems to be universally conceded that the brain that plans and guides is worthy of more honor than the hand that executes; the general deserves more than the private soldier; the architect than the builder; the investigator who plans the work than the chemist who makes the analyses. Few will object to such a distribution of rewards as this, and certainly no one will claim that a chemist who, machinelike, simply follows directions, without thought or interest in the matter, can fairly claim recognition for anything more, perhaps, than manipulative skill and honesty. But, on the other hand, it is fair to say that such analysts can truly be called analytical chemists. Does not the genuine analytical chemist embody within himself not only the capacity of brain to wisely plan his method of attack, to conceive which one of the possible reactions in the case it will be best to employ, but also the requisite manipulative skill, to carry out the line of action decided upon? To my mind, these two things, viz., the brain power necessary to plan the work, together with continual activity of the brain while the work is going on, and the skilled and trained hand requisite to do the work, are necessarily coexistent at the same time in the good analytical chemist, and woe be to that chemist who tries to put them asunder! The analyst whom chance or the exigencies of earning his livelihood have thrown into a situation where day after day he must, for a time at least, do the same thing over and over again, and who does not, even in this situation, use his brain constantly, does not each time he adds a reagent think what is going on in the beaker; does not each time he washes a precipitate think what he is washing out; does not every time he makes a weight take a genuine interest in the result, and even the hundredth time that he makes the same determination is not on the lookout for some flaw in the method he is using, or some possible new reaction in connection with it, such an analyst, I say, will stand a good chance to remain a routine chemist all his life.

On the other hand, what shall we say of those chemists who plan out a line of investigation and are content not to make the necessary analyses themselves? We are quite well aware that at the present time this is a very common method of making investigations, and we can, of course, understand that pressure of other duties may make it impossible to pursue investigations in any other way. But we cannot regard this state of affairs as, to say the least, anything less than unfortunate. If we may trust our own experience, the time spent in making the analyses required by one line of attack on a stubborn problem is most valuable, in the opportunity which it affords for carrying the problem in mind, and planning out other lines, in case the one in hand does not succeed. Moreover, still more valuable is it to make the analyses yourself, in that while doing so you so frequently get suggestions from the work that are the very ones upon which final success depends. I wish there were time to illustrate this point as its importance deserves, but the history of chemistry and your own experience will have to furnish them to you. To our minds it is hard to overestimate the importance, especially to a young investigator, of his doing his own analytical work for himself. If we read rightly, this was the almost universal habit of the old masters of our science, and we greatly fear that those chemists who from choice delegate their analytical work to others will find, after years of such delegation, that their reward of successful investigations is very small.

A single thought further. At the present time so much applied chemistry is either based on analytical work, or has analytical work as an almost essential constituent of its existence, that in a paper discussing analytical work a few words may not be amiss on the relations between pure and applied chemistry. Without wishing to touch in the slightest degree on mooted or disputed questions, it may not be unfair to say that, while the applied chemist does truly, as the name indicates, in the mass of his work, utilize or apply the discoveries of others to useful effect, it does not at all follow that in the field of applied chemistry no discoveries yet remain to be made. It is certainly not too much to say that no thoughtful chemist has ever worked for any length of time in any field of ap-

*Trans. A. I. M. E., 19, 614.

plied chemistry without finding himself surrounded with problems involving new and unknown reactions; with problems, am I not safe in saying, requiring for their solution as good appliances, as deep study and as keen thought as any that occupy the minds of the pure chemists. These problems continually force themselves upon him, and his only regret in the matter is that the time at his disposal does not permit him to solve them as fast as they arise. A prominent feature of these problems in applied chemistry is worthy of close attention, viz., they generally have immediate useful applications as soon as they are solved. The applied chemist usually makes an excursion into the unknown because some difficulty has arisen in the course of his regular work, or because some new, more rapid, or more economical method of accomplishing results is desired. He may succeed in finding a new reaction or in utilizing an old one, as the basis of a successful commercial process, or in modifying a manufacturing method in the interests of both economy and speed. But whatever his work, the immediate useful application of the information he secures is both his stimulus and guide. He may not be able, from lack of time, to follow his work up, and find the complete relations of the facts ascertained to the other branches of chemistry, but this is his misfortune rather than his fault, and this condition of affairs, viz., being unable to follow out to completion lines of research one started on, is, if we understand the matter rightly, not characteristic of the applied chemist alone. This much being said, let us ask in what respects the pure chemists resemble or differ from those who work in the field of applied chemistry.

They certainly are alike in this, that neither of them can devote his whole time to original work, but both must devote no small portion of their energy to other lines than making investigations. There may have been a time in the history of chemistry when investigators were so fortunately situated that they could devote their whole time and energy to finding out new truth and giving their results to the world. All honor to such investigators. Moreover, we all know that occasionally an appropriation of funds or an endowment is made for research in some special field. But truly, would it not be too much to say that the work of any large percentage of the pure chemists of to-day is the result of any such fortunate circumstances? Furthermore, the pure and applied chemists are alike in that in their original work both are seeking for the truth, and if they are successful, both are adding to the sum of human knowledge.

They differ, as it seems to me, principally in this: First, the researches of the applied chemists being largely made in the interests of corporations or manufacturing establishments, the results of these investigations in many cases are not at once available to the world, except in so far as they lead to diminished cost of production. Those who have paid for these researches naturally feel that they should be allowed a period of time at least to recoup themselves for their expenditures, and so they protect themselves either by patents or secrecy. But this is only a knowledge of the truth deferred. Sooner or later the results of the investigations of all applied chemists are added to the great body of accumulated chemical knowledge. The pure chemist, on the other hand, at once gives the results of his investigations to the world, and is quite content if the publication of his researches shall bring him as his reward a modicum of appreciation from his fellows. Second, in their original work, the pure chemists differ from the applied chemists in the ulterior purpose for which the investigation is undertaken. As has already been stated, the applied chemist usually undertakes an investigation, tries to find new truth with the avowed purpose of at once utilizing this truth as soon as it is found. Not so the pure chemists. The problems which they attack and solve so successfully have no necessary relation to subsequent utility. The truth which they discover and put on record may be found to be useful at some time, but its possible immediate utility or non-utility is not taken into consideration by the pure chemist, either in his choice of a subject for investigation or in the prosecution of his work. The truth for the truth's own sake is his motto and guiding star.

If we have diagnosed the case correctly, then, the principal differences between the pure and the applied chemist are that the latter withholds the results of his work from the world for a period of time, while the former gives his at once, and that the latter is, in his original work, seeking for truth that is useful as soon as it is worked out, while the former neither knows nor cares whether the truth that he discovers is either now or at any future time turned to practical or useful effect. Let me not be misunderstood. I am not attempting to belittle in any sense the work of the pure chemists. They are worthy of all honor and respect. But, on the other hand, I am not at all willing to have the work of the applied chemists made light of or treated as though it were in an inferior field. To my mind there is no occasion for either to belittle the work of the other. The field of chemistry is so broad, the amount of unoccupied ground in every branch of the science is so great, that there is neither time nor energy for struggling as to who is greatest or who is least, but in whatever line a man's tastes, opportunities, or the force of circumstances may lead him, whether as pure or an applied chemist, whether organic or inorganic, whether theoretical, physical, or agricultural, whether analytical or synthetic, provided in his mind at all times the love of truth is above all, and honest work is being done, he is worthy of recognition, honor, and respect.

Railway accommodations in China are of a very primitive character, says Uhland's Wochenschrift. The cars are fitted out in the simplest manner possible, plain wood being used, the employment of cloth and leather being avoided on account of the uncleanliness of the natives, and metallic parts are used as sparingly as possible, as Chinamen can hardly resist the temptation to remove and steal them. The lowest class of Chinamen travel in open freight cars, taking an immense amount of baggage with them, and are unmindful of wind and weather. Often a Chinaman will take an entire freight car for himself and his family. Fares are very low. For the convenience of civilized people, the mail cars have compartments fitted with greater comfort.

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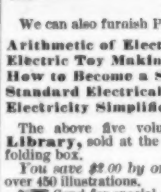

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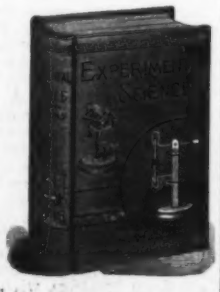

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TABLE OF CONTENTS.

PAGE

I. ANTHROPOLOGY.—Anthropology.—3 illustrations..... 19133

II. ARCHITECTURE.—Monument in Commemoration of the Battle of Leipsic in 1813.—2 illustrations..... 19127
The Paris Opera House.—4 illustrations..... 19119

III. BOTANY AND HORTICULTURE.—The Germination of the Truffle.—4 illustrations..... 19130

IV. CHEMISTRY.—The Dignity of Analytical Work..... 19132

V. MECHANICS.—A New Rack Saw Guard.—1 illustration..... 19122
Determining Lengths of Crank.—2 illustrations..... 19122
The Spencer Automatic Screw Machine.—4 illustrations..... 19123

VI. MEDICINE AND HYGIENE.—The Determination of Sex..... 19134

VII. MISCELLANEOUS:
Electrical Notes..... 19125
Miscellaneous Notes..... 19125
Selected Formulæ..... 19125

VIII. PSYCHOLOGY.—Psychological Cause of Laughter..... 19134

IX. TECHNOLOGY.—Manufacture of Albumen at Chinkiang..... 19127

X. WARFARE.—The German Maneuver Fleet in a Storm on the Baltic.—1 illustration..... 19127
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PAGE
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